

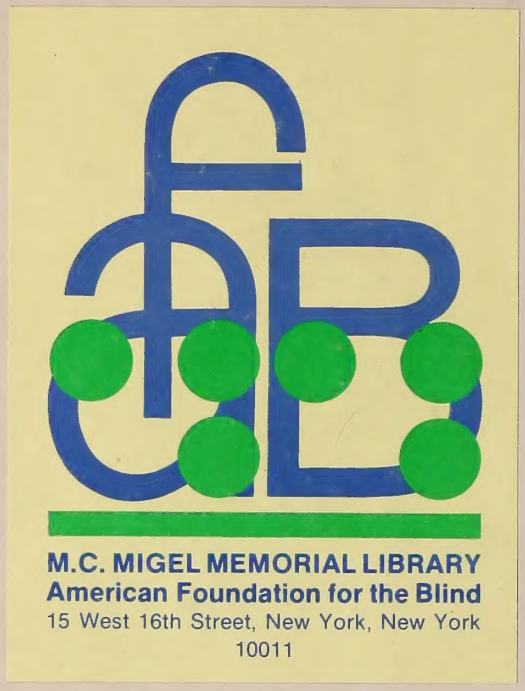
Memory of Blind People



studies in
touch
movement
and audition

Dr. V. K. KOOL
Indian Institute of Technology
Bombay - 400076.

Project Report
Ministry of Social Welfare,
Govt. of India, New Delhi



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Project Report

Ministry of Social Welfare,
Govt. of India, New Delhi

(Information Processing in Short Term Memory of
Physically Handicapped
Using Tactite, Motor and Other Methods)

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The project on which the present report is based was funded by the Department of Social Welfare, Govt. of India. However, the responsibility for the fact stated, opinions expressed, and conclusions reached is entirely that of the project director/ author (Dr. V. K. Kool) and not of the Department of Social Welfare, Govt. of India.

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P R E F A C E

In response to my research proposal submitted in 1974 about which I had virtually forgotten owing to my reluctance to trot behind papers, one hot summer day in 1976, I received a telephone message from the then Deputy Secretary, Department of Social Welfare (now a Ministry) that the Committee appointed by the Government of India had approved my research plan and the Ministry was willing to sponsor it. I had long cherished to work for the blind people and this was a consummation which I could not delay. I am glad to mention here that since then for all my needs I have received a very encouraging and favourable response from Mr.Lal Advani, the then Special Officer in the MSW and now Director of National Institute for the Visually Handicapped, Dehra Dun. After he had left Delhi, Mr. J.C. Jatley, Joint Secretary, and Mr. Tej Prakash, Deputy Secretary, also attended to my problems promptly and gave me required assistance. Support from other officers - Mr. L.D. Trikha and Mr. S.R. Pandey was also readily available. The purpose of writing this is to inform the academic community to shun their fears regarding acceptance of a Government sponsored project for reasons of bureaucratic problems. I cannot say if this experience was exceptional.

After the first blush of enthusiasm was over and I began to settle down on the task, the very first problem of recruiting staff had completely demoralized me. Out of several students who every now and then used to keep contact with me for some employment, no one above average among them came forward to work with the blind people. In response to the advertisement in two leading national daily newspapers, only two applications were received including one from Mr. S. Singh (now Dr. Singh) who happened to be my student at the Banaras Hindu University and had some sentimental reasons to work with me but had no special liking to work on the blind people (but not so now, I believe). This point has been deliberately mentioned here to caution the scholars interested in research on the blind people.

Once we had settled staffing and some other minor problems, the work was carried out smoothly except in the last stage when computation of data became a great headache due to several reasons. In the meantime, sufficient motivation and inspiration for the work reported here was intermittently received from several sources: acceptance of our work in the form of a chapter in the most prestigeous volume in our research field, ATTENTION AND PERFORMANCE, Vol.VIII, edited by Prof. R.S. Nickerson and published by Lawrence Erlbaum Associates, U.S.A., research articles in Journals and symposia/conferences in India and abroad; award

of Ph.D. degree to Dr. Singh who worked on an offshoot of the research project; and above all from Mr. Lal Advani, Director of National Institute for the Visually Handicapped, Dehra Dun.

It is just a coincidence that this work is appearing during 1981 which happens to be the International Year of Disabled Persons. Still more encouraging is the fact that focus on research on blind people, envisaged as early as in 1974 in our proposal submitted to the Government of India, figures as one of the 5 principal objectives for this year: Encouraging Study and Research Projects.

The main purpose of this work is to report the memory characteristics of the blind people for movement, touch and auditory informations and to examine how they process, store and retrieve material at short delays. We All know that memory is the basic mechanism for all types of activities and without it an organism will be no different than a vegetable. In the acquisition of skills its role is still more important because sensory inputs from various sources tend to integrate, monitor and programme the response such that the act becomes highly automatic and is executed without conscious attention. Since vision plays a key role in providing precision, exactitude and satiation for variety in the sighted people, it is extremely important for acquisition of skills although it is not

essential for all skills and also sometimes undesirable. How reproduction of various tasks is dependent on visual reference system in storage and retrieval processes is investigated in several experiments in the present work besides delineating those which are relatively free from it. The approach adopted in this pursuit is based on current models of information processing and neurophysiological studies on motor control as applied to basic psychological processes. Therefore, the discussion has naturally grown highly technical but our attempt has always been to present it in the most elementary way without over-simplifying the issues. Owing to this reason the first two chapters, namely, Effects of Blindness (Chapter 1) and Human Memory (Chapter 2) have been deliberately inserted to help those who are somehow interested in these areas but at the same time are unable to keep track of the developments in fields other than those in which they specialize.

The findings based on our endeavour begin with Chapter 3 on Motor Memory. It reports a series of experiments undertaken in this area to examine what role preselection, distance, location, response biasing, prior activities, interpolated tasks, etc play in recalling movements. While doing so, it was possible to show how blind subjects, who depend mainly on kinesthetic information,

differ from their sighted counterparts. To evaluate the status of findings in terms of the models of motor control, particularly the motor programme theory, various explanations were offered based on the subtle nature in which the information handling capacities of the two groups differed. In this regard, the findings on preselection, location and distance have several implications - both theoretical and practical.

In Section I of Chapter 4, 3 experiments are reported on touch; whereas in Section II, 2 experiments are described to examine the effect of bimodal presentation (tactual and kinesthesis). Emphasis in this chapter is laid on the role played by capacity and structural factors besides highlighting consequences of modality specific presentation.

Chapter 5 deals with visual/auditory processing of material by blind, deaf and normals with special reference to effects of overloading the limited short term store. In the last chapter a summary of the work is reported along with several suggestions and recommendations based on the obtained results.

We had full plans to conduct several more experiments based on electromyographic recordings (EMG) of the blind people to explore response planning, reaction time, movement time, termination, active phase, etc but unfortunately the

Government did not permit us to import an EMG recorder for which money and approval of sponsoring agency (Ministry of Social Welfare) was available. Any way, the experiments reported in this monograph have laid the basic foundation of our work and have already set a chain of studies which are being hotly pursued by several research scholars in our Institute and elsewhere. We hope that many more will join to accelerate this type of work in near future.

I have realized better than ever before that more than monetary or material assistance research needs a team of dedicated and sincere workers who not only carry the task faithfully but also make critical appraisal of the work through their participation at various levels, e.g. doctoral work, seminars, symposia, etc, to sharpen the level of analysis of the project leader. This is especially so when we deal with research areas which are somewhat diffused and have interdisciplinary character. I should consider myself lucky in having a good team of dedicated workers. Without the untiring and sincere work of Dr.Singh, I confess, the present work would have been difficult, if not impossible, to complete. Both Ms. Mukta Rana and Mr. K.C. Pathak invested the very best in themselves. I become nostalgic of the reminiscent past when under pressure of work these three comrades worked continuously for 3 days to enable me to complete a manuscript. What else one can expect and what more is required as a proof for dedicated work!

The staff was engaged following the principle of division of work. Dr. Singh, Ms. Rana and Mr. Pathak worked on motor, touch and auditory aspects, respectively. Ms. Raj Gupta, a research scholar in the department who is planning to work on the blind people, also assisted in the preparation of this manuscript.

The cooperation offered by the principals of Schools/ Workshops of the blind and sighted in providing the facilities for work is commendable. No less significant was the assistance from the blind and normal subjects who participated in the experiments. In fact, some of the experiments, e.g. the one on prior activities in Chapter 3, took about 4 hours on each subject. It is beyond my words to express how cordially and sincerely they cooperated to enable us to attain our goals.

For computation of data, Dr. O. B. Sayeed, my colleague, had rendered valuable assistance and I am personally very grateful to him for his contribution. Prof. Bapat of IDC, and Mr. Ghosh of Mechanical Engineering Work Shop had assisted us in designing the equipment and we sincerely thank them for their valuable contribution.

I place on record my appreciation of the assistance given by Mr. Girish Agarkar of Industrial Design Centre; Mr. Kashipati and Mr. Hussain of C.R.L., Physics Department; Mr. Kunjukunju of Humanities and Social Sciences Department;

Mr. Kulambutay of Chemistry Department; Mr. Pawar of Central Cyclostylling Unit; Mr. Raghavan and others of I.I.T. Press, for preparation of tables, charts, graphs, electrostencils, cyclostylling, typing, etc.

And finally, it was a worthwhile experience of 4 $\frac{1}{2}$ years for me not only from the academic angle of my work on blind people but also in terms of sharing a wide variety of experiences with them and my colleagues and friends without whom this work would not have come to the present shape.

JUNE, 1981

I.I.T., BOMBAY

V. K. KOOL
Project Director

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CHAPTER 1

EFFECTS OF BLINDNESS

It is very well known that blindness causes several personal, developmental and social problems, but what these problems are and how to reduce them is still a very open challenge to academicians in several disciplines - psychologists, educationists, sociologists, linguists, psychiatrists, etc. For example, at one time we accepted and followed the views of a great child psychologist, Piaget (1952), on the developmental deficit concerning conservation and other cognitive and reasoning abilities of the blind children but in the past two decades his thesis has been partly rejected and on several issues revised. And yet we were tempted to develop our training programmes on the lines suggested by Piaget. In fact, Getman (1965), who has developed a Visuomotor model of development sequences of a child's performance in acquiring motor and perceptual skills, believes that many learning programmes utilized these days assume that the children had already successfully achieved the motor and perceptual levels and are moving toward the cognitive levels. On the other hand, due to poor knowledge about the learner, we tend to design

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1.2 training programmes which fail to do justice with their actual potentialities and restrict them to several boring and repetitive type of tasks which later cause several ego problems and frustrations. Surprisingly, Getman who himself is an optometrist, committed similar error by overemphasising the role vision plays; for we know now that several groups of blind children not only match equally with the learning of their sighted counterparts but also happen to give superior performance in some tasks. So, the fundamental question before us is: how much do we know about the learner before we plan their training and rehabilitation. To say that something should be launched first before we embark on the scientific and methodologically sound programmes is not advisable at least for a long term comprehensive strategy to ameliorate the lives of sightless who are already less blessed than several others on the land.

In this chapter an attempt is made to focus in general some of the important problems arising out of blindness and to show how the blind people tend to cope with them. Although their problems and coping up behaviour have a very wide range - perceptual, motivational, social, sexual, etc only a brief description will be given to draw a profile of a sightless person.

1.3 PERSONALITY DEVELOPMENT AND ADJUSTMENT

It is very difficult for a sighted person to imagine what life would be like without vision because even if a person closes his eyes he normally cannot give up the use of visual imagery and therefore he only partly gets some idea of the impact of darkness. In other words, for a sighted person it is practically impossible to experience what it really means to be completely blind. On the other hand, blind people are unable to understand what it means to be in the light. Unlike sighted people who live in darkness when they close their eyes or have no lights, blind people do not 'live in darkness because darkness is a visual quality of which he has no experience. His mental pictures are derived entirely from experiences of the remaining senses' (p. 91, Lowenfeld, 1950). In other words, seeing people cannot put themselves in the position of a blind person or vice versa.

Blind people can make effective adjustment with their environment provided the environment is conducive to their living. However, when they are brought to a new group, say from family to residential school, they lose contact with family and fail to make normal friendships in their community resulting in their growing as a social misfit.

A study of adjustment problems of visually impaired children conducted by Ross and Gallagher (1976) revealed

1.4 that behaviour problems of blind children varied with age and schooling. To study behaviour symptomatology, they used Devereux Behaviour Rating Scale and observed frequent impatience, comprehension problems and irrelevant responses in elementary school children. Rating of house parents were also obtained on social isolation, unethical behaviour, proneness to emotional upset, distractibility, etc. Earlier, in a study conducted by Bauman (1964) in which a comparison was made between 150 boys and girls attending residential school for the blind and the sighted children, it was found that moderately visually impaired adolescents showed higher anxiety and insecurity than the severelly impaired. However, such studies are not very conclusive because there are enough empirical evidences to show that blind people have low manifest anxiety, and that their anxiety level tends to increase with age. There is a great deal of dearth of such studies in India and not much can be generalized about the anxiety levels of blind people unless a very clear and comprehensive study is conducted on this problem.

A number of personality and developmental problems of the blind children are related to their own self-concept and socialization for which a lot depends on how society accepts them. Blindness arouses a more emotional reaction than do most other handicaps and many seeing people feel uncomfortable in the company of blind people. Several

1.5 others present themselves in a style which is not natural to them, presumably out of pity or a liberal sense of admiration. Also, there are people who are frankly ashamed of the visually handicapped individuals and try to avoid them. When normal children learn this type of behaviour and devalue or ridicule blind children in school, the latter begin to feel small and inferior and this leads to maladjustment.

Self

Direct sensory experience is very important for the development of self because it helps the child to differentiate himself from the non-self. Among all the senses, it is the vision which is most elaborate and rich in details to provide most of the direct experience which we first encounter and rely upon. In the absence of vision, the blind child needs such direct experience to be brought to him before he can experience it directly. In other words, unless some concrete effort is made by the blind child himself or the educator, blindness restricts the child from detailed, direct experience.

Owing to lack of vision, the blind child fails to hold direct experience for a long time. It vanishes too easily from his awareness. For example, if a toy drops, it is lost unless it falls within his reach and he happens

1.6 to touch it. The net results of such effects are that the child loses interest in his environment and gradually and gradually passivity becomes the hallmark of his behavioural pattern.

Since vision serves more efficiently than the other senses for differentiating external objects from one another and of the self from others, to the blind child non-self consists of a confusing, ill-defined, diffuse, something that comes and goes. It lacks sharpness and contrast and, as such, provides a poor background against which to draw the distinction between it and self (Scott, 1971). The sighted child learns that non-self is vaster and more complex than self but the blind child, in sharp contrast, finds his direct experience limited to his own body, the result being that his own self conception assumes greater magnitude and significance than that of non-self. All this leads to the blind child to seek self-stimulation and motivation to action as he becomes inclined to turn to himself. In short, the blind child explores his body, whereas his sighted counterpart explores his environment.

Several studies show that maturation of the blind infant is retarded. For example, the coordination of vision and grasping occurs at approximately 4 $\frac{1}{2}$ months but the blind infant does not coordinate the actions of sound and grasping until approximately 6 months later, at around 10-11 months of age. According to Fraiberg, Smith and

1.7 Adelson (1969): 'The totally blind infant's hands may not unite at midline at all, and maturational sequence that leads to coordinate use of the hands and reciprocity between the hands can be impeded' (p. 134). Appropriately stimulated blind baby will at five months of age grasp objects upon contact, make fleeting pursuit movements, and explore a table surface. But a normal blind baby deprived of early tactile stimulation will not be able to do so. Hands need to be developed and fingers extended in order to support the body in crawling. Since existence of external stimuli for reaching is usually provided by vision, there is a marked delay in creeping and independent walking in totally blind infants. Moreover, with the absence of vision there is also no incentive for the baby to sustain an elevated head position.

Social Learning

Blind child is not guided by the mother's expression of interest in his activity, and therefore, lacks some of the incentive to repeat achievement. Visual loss affects imitative learning of facial expressions and gestural movements. Blind individuals show less facial expressiveness and fewer gestural patterns and are unable to associate posture and facial gestures with appropriate role behaviour.

1.8 It has been generally observed that blind children behave very much like adults. This is so because in the absence of vision they learn about world mostly through adults, and that too by means of meaningful, intensive interaction. Therefore, it is very natural that they cannot appreciate subtle variations in roles. They usually acquire a stereotyped concept of parents' roles learned through books and word-of-mouth. However, those blind children who have brothers and sisters show more effective and healthy interaction than those without siblings.

Psychologists and educationists have found that blind children have problems of ego development and self image. When blind people compensate for their inadequacy they grow along the line of a compulsive personality. This characteristic coupled with a false sense of security by failing to meet life aggressively develops in them hysterical responses which only add conviction to their feeling of inadequacy. All this makes the blind people apparently erratic, inconsistent and sometimes difficult. 'His social world', writes Lowenfeld (1950) 'tends to approve, develop, and exploit his compulsive compensations, and at the same time to deplore and baffled by his hysterical responses' (p. 176).

Neurotic reactions of the blind people have been found to be somewhat typical. The most important one is their inadequate emotional response which often causes failure in

1.9 them to evaluate others mainly in terms of their own self evaluations. Another tendency generally found in blind people is their tendency to avoid responsibilities and social relationships. It is generally believed that successful blind people are those who mature emotionally as they advance vocationally, rather than those who are pushed up in hierarchy by social agencies. Another very important symptom of neurosis is high anxiety level. As stated earlier, manifest anxiety level has been found to increase with age among blind students (Hardy, 1968). A blind person tends to feel more concerned about the affection of the other towards him than he feels satisfaction in his deep affection towards the other.

Fears

Analysis of fears of blind people show some typical characteristics. They are frequently disturbed by a fear of being observed by others. Of course much depends upon how they understand what it means to be watched. For example, if a blind person is told not to do this or that he feels something is done to him which he cannot do to others. Bauman (1950) reported that lack of security of financial difficulties were most frequently expressed by all classes of blind people. They also showed concern with their failure to understand deeply social contacts. It has also been reported by people with some intact vision that people take advantage of them.

1.10 Play

Play is very important for the growth of children because it bridges the gap between concrete experiences and abstract thought. Play is both imitative and imaginative. Unfortunately, the visually handicapped child with reduced visual input has fewer opportunities to observe adults besides fewer encounters as far as variety of living experiences is concerned. It is difficult for him to understand how others are evaluating him. He often fails to put himself into the position of another person and makes a poor show in evaluating his own behaviour from that point of view. If praise is heaped on them for their slightest effort, it gives them a very wrong conception of their self image.

Mobility

In the absence of vision it is a monumental task for the person to move and explore the environment. When visual functioning is impaired, the selection of cues and sensory data would become a slower and more difficult process. Although use of cane and dog guide are helpful to both extent of travel and the feeling of self confidence and pleasure in independent travel, much depends upon good mental ability and personality of the traveller. It has been found that those who become blind in early age travel more freely and frequently than those who become blind late in life.

1.11 Blind traveller becomes thoroughly familiar with a specific route to be travelled, if proper coaching or training is given. However, many times the landmarks or clues which they use for guiding their movements are shifted and in the absence of such landmarks they face great deal of stress. It is often observed in the city life that the objects do not remain in the fixed position or they are camouflaged by some new ones. A major problem faced by blind people in interaction with others, is the degree of trust. It is very difficult for a blind person to trust another person, particularly when he is mobile or gets somewhat varied report of an event. However, blind people have got to depend upon others for seeking information as they themselves are unable 'to see' what is happening around them. Therefore, dependency and trust together cause formation of mixed attitudes about people and events in the minds of blind people. In their prevailing confusion sometimes they refuse to accept help from others without really appreciating the gravity of the situation. This often leads to initiation of a complex pattern of self stimulation in response to his own internal impulses, without any comprehension of the appropriateness of his activity.

In short, in his mobility the blind person is fearful of physical injury owing to unpredictability, unfamiliarity and accelerated change of situations, persons and things,

1.12 particularly in the urban environment and it is recommended that besides dog and cane help, they should be trained to adopt to new situations, accept help from others and participate in therapeutic session such as desensitization to improve their mobility. This is particularly important because a number of blind people have good memory for direction and orientation (Rutberg, 1976).

Language

We all know that our language is quite barren without visual imagery and there is hardly much which could be conveyed in terms of tactile and kinesthetic experiences. As such blind people do not have verbal realism like those of the sighted people. For example, a blind person does not know what a yellow or blue colour is and hence he loses tremendous richness of details which sharpen the level of perceptual analysis. Sensory basis of language is limited in them and to that extent the common ground of shared meanings between them and the sighted people also differ. The language of sighted people is heavily guided by the characteristics of visual imagery. Imagine how much the same language would become poor if it becomes devoid of visual orientation. Since the blind people live with the sighted ones, the language the former pick up is inappropriate to their mental frame as is often seen in their verbalization independent of meaning. The adults who

1.13 socialize him believe that sound, and not touch, is the dominant sense modality.

For the seeing people, then, the language used by blind children manifests some abnormality. According to Scott (1971), they often manifest 'the word salad' quality which, in other contexts, is associated with certain autistic and schizophrenic syndromes. Words and phrases which in combination are nonsensical may be endlessly repeated by them to convey meanings which are not shared by the sighted listener. In her detailed case study of a blind child, Jerry, Urwin (1977) reported that a blind child's early language consists entirely of ready-made phrases which they may or may not use appropriately to context. She also found that body-action games contributed to the build-up of a vocabulary of words and phrases centered around his own body movement. 'Although Jerry's parents might hear him use the 'name' of the thing to accompany his own ramblings and exploration of the furniture, he never volunteered these words in interaction' (pp.150-151).

A very common and universally known aspect of language difficulty among the blind children's acquisition is of I-You pronoun distinction. In their study on congenitally blind children, Adelson and Fraiberg (1973) studied this phenomenon. Although several objections have been raised about the details of their findings, the fact remains that

1.14 the capacity to represent himself as an 'I' and reversibility of roles between 'I' and 'You' is found to be a problem in the language usage of the blind child.

A very curious factor reported by Burlingham (1961) in his study of normally developed blind children is that by the time they reach nursery school age, they may even out do the seeing in the development of language for talking about objects and events.

Piaget's View

It is important at this point to give some reference to Piaget's theory of development (1952) of blind children although it is somewhat controversial, particularly on the language aspect. According to him, blind child suffers a developmental lag, i.e. slowdown in the speed of development through the different stages: sensorimotor (0-24 months), preoperational (2-7 years), concrete operations (7-11 years) and formal operations (11 years and upward). A number of examples have been cited to show how maturation, learning, imitation and play are affected in the development of the blind children. Piaget believed that language does not constitute the source of logic but rather is structured by it. Although his views are not acceptable to several scholars, it appears that the contention that blind children are deficient in logical operations is reasonable. In tasks like seriation or classification blind and sighted

children are equal but after 8 years of age blind children lag behind, especially in verbal tasks (Swallow, 1976).

Imagery

In the mental development imagery plays an important part. According to Piaget, if blindness occurs before the age of 6, visual imagery is believed to be atrophy. After the ages of 7 or 8, the imagery becomes anticipatory and so better able to serve as a basis for the operations. Some studies reported differences between the blind and sighted children in reproducing body parts, the blind children being inferior to the sighted ones so much so that they did not reproduce ear or fingers which are importantly related to sound and touch which they mostly rely upon (Swallow, 1976).

Intelligence

Several studies using Wechsler Intelligence Scale for children (WISC) show that on vocabulary, comprehension, and similarities blind subjects were inferior to those in the sighted group (see review by Swallow, 1976). They also show a tendency to perform abstract conceptualization from a concrete or functional point of view. It has been reported in International Archives for Research on Deficient Visuals (p. 86, 1971) that no correlation was found between intelligence and visual activity.

1.16 In India Paknikar (1978) has developed a test of intelligence for the blind contending that performance tests based on tactual and kinesthetic experiences of the blind are most suitable for measuring their intelligence. His battery of performance tests include Circle Formation Tests, Sorting Out Pairs of Similar and Equal Forms in Thick Plastic, Roughness Discrimination Test, Weight Discrimination and Construction of Steel Rods Tests. A very surprizing observation reported by him is that repetition of digits, which has been regarded as a standard for memory, was found as a difficult test on blind children who were otherwise quite intelligent and contradicted the popular notion that auditory experiences of the blind are better than those of sighted persons.

PERCEPTION

What visual imagery does to the sighted people, schema having a temporal plan of various impressions based on haptic experiences does to the blind. Unlike sighted people who can identify the objects by its shape at a time, the perception of blind people is based on a sequence of variations in muscle tension such that each separate tactile impression is related to the next and mentally held together to form a percept. However, visual imagery is full of rich details but not the schema as we know that it does not exist for some objects, e.g. moon, objects of motion, etc.

1.17 This is because blind people primarily depend upon tactual experiences and not all of them are possible through direct experience. Therefore, the sense of touch provides only partial knowledge.

Since blind children fail to strike proper balance between concrete, objective and spatial representations, their perception of distance, perspective angle and relationships between objects are different as compared to the sighted counterparts. As stated earlier, Piaget found that blind children were slow in conservation. In their original study of conservation Piaget and Inhelder (1948) tested the conservation of mass, weight and volume to determine if the child could tell that a quantity remained the same after it changed in appearance. They found that conservation was related to age: 9-10 years for conservation of mass and 11-12 years for conservation of volume. A number of studies on the blind children have supported Piagetian viewpoint concerning their developmental lag (Miller, 1969; and Swallow, 1976).

Contrary evidences for Piaget's viewpoint have also been reported in several studies. Higgins (1973) failed to trace the developmental lags emphasized by Piaget. So did Cromer (1973) in his comparative study of blind, sighted and sighted blindfolded in the age group at which conservation was attained. A very detailed and neatly executed study

1.18 on this issue was reported by Gottesman (1976). His results show that the rate of conservation development for blind children was slower than that of the sighted at the 4-5 and 6-7 years. For all the groups conservation of mass was the easiest, followed by conservation by weight and volume, the last being handled accurately by only a few. However, with increase in age level to 8-11 years, the blind group performed as well as the other groups. Summarizing his findings, Gottesman remarked: (a) 'vision and visual imagery were not necessary for the performance of Piagetian tasks of haptic perception and conservation development. Touch and tactile imagery may explain the ability of the group of blind children to respond successfully. (b) The sequential development of age and stage were found to be appropriate to both groups. (c) Vision was not necessary in responding to actual terms' (p. 99). Raising his discussion further, he believed that the tasks at the older age levels invite more integration processes of cognitive functioning, rather than dependence on the less sophisticated sensory discriminatory abilities. It is likely that more information is conveyed through the visual perceptual processes than through the tactual processes at earlier stage and hence blind children perform less accurately than the sighted ones at that age level. Later both visual and tactual modalities relay sufficiant amount of information to make appropriate conservation responses.

1.19 A very interesting finding in Gottesman's study was that the blindfolded sighted subjects performed poorer than the blind group on both mass and weight tasks when the two groups performed intramodally (tactual-tactual). It indicates that the visual modality caused more confusion and interference than did the tactual modality in responding to the tasks. A detailed examination of the intramodal and intermodal effects will be made in Chapters 3 and 4.

Only a few will disagree with the statement that knowledge of spatial relationships requires support of vision and that in the absence of vision it is very difficult to derive effective knowledge of space. At least for movement in space, writes O'Connor and Hermelin (1978), visual images seem to have been relevant when visual experience was very recent. However, there has been considerable debate on this point and over the years two divergent views have emerged. One viewpoint stresses that vision is primary and necessary for spatial and kinesthetic representation. For example, Goldstein and Gelb (1920) held the view that only through visual conceptions does spatiality enter into tactual experiences. The other viewpoint as reflected in Berkeley's philosophical argument is that spatial world is accessible to touch and kinesthesis but our visual impressions are merely signs. Thus, congenitally blind lacking only in a nonspatial modality, must have awareness of space. Still others take

1.20 a middle position. They believe that blind must have some notion of space although their concept may not be identical to that of the sighted (Revesz, 1950). Further discussion on these viewpoints would be made in the chapters on motor and tactual memory.

Braille Reading

Blind people read by means of touching elevated dots. The diameter of each dot is 1 mm, its elevation is 0.5 mm, the distance between dots for one letter is 1-2 mm and the distance between letters is 2-3 mm. The size of a letter is 5-6 mm in length and 2-3 mm in width. With this size, the tip of the index finger can feel all the components of a letter at once as a single spatial grouping of tangible dots. Although it is possible to reduce the size of these letters but it is not very desirable. The reader usually moves his right and left index fingers together for reading but they differ widely in coordinating their hand movements. It has been found that Braille reading is affected by temperature fluctuations.

When a comparison is sought between braille and visual reading, it was found that braille code itself is responsible for slow reading. Although there is no difference in reading rates of letters with visual and braille letter-by-letter modes, this being 19.5 and 18 words per minute respectively, the rates of the two modes differ to a great extent when a

1.21

comparison is made for word-by-word rates at a time: whereas with visual mode it is 108 words, it is only 44 with braile (Troxel, 1967). However, such findings do not reflect that cognitive processes of the blind are slower than those of the sighted but they do indicate that reading through sense of sight is more compatible than touch. It is also possible to increase the speed of braille reading to 320 w.p.m. by automatically moving the braille print under the finger tip, but then it is still not a good match to the visual reading.

Recent researches on braille reading help in understanding how tactual inputs are represented in memory. Practice in Braille reading is related to a change in tactual and spatial strategies. Millar (1975) reported that blind children can encode tactual inputs either tactually or verbally but the underlying processes are not similar. This point will be discussed in detail in the chapter on tactual memory.

Cerebral Hemespheric Dominance

Each hemisphere of the brain is mainly associated with one side of the body, the right brain controlling the left side of the body and the left brain the right side of the body. Recent researches show that the right hemisphere contributes to non-verbal, visual and spatial functions

1.22 than does the left; whereas the left one regulates reading, location and namely objects, etc (Sperry, 1964). The cerebral hemispheres are linked by discrete bundle of nerve fibres, called commissures, that form reciprocal connections between the two hemispheres. Learning in one hemisphere is usually inaccessible to other hemisphere if the commissures between the hemispheres are missing.

It is generally believed that good braille readers usually read bimanually, i.e. moving right index finger lightly across the page followed at some distance by the left index finger. In an early study Fertsch (1947), while comparing three groups of braille readers (left hand better than right, right hand better than left and both hand equal) found that those with incomplete cerebral dominance were found to be better readers than those in other two groups. However, the current viewpoint of this issue is not so simple because several perceptual and motor factors must be considered before a clear inference is drawn. Researchers by Hermelin and O'Connor (1971) show that the left hand performance was superior with braille readers and they link it to right hemisphere superiority on the assumption that braille letters involve spatial input. Summarizing their findings, they concluded: 'While it could be argued that the advantage of the left over the right index finger for Braille reading may be due partly to early training and practice, this does not apply to the two centre

1.23 fingers. The children stated emphatically that they normally never used these fingers for reading, yet there was a highly significant effect in favour of the left centre finger. It thus seems possible that the brain treats input such as Braille reading material as spatially arranged items, to be more efficiently analyzed by the right hemisphere before or while verbal coding of the material occurs in the left' (p. 470).

Two Point Threshold

If 2 points of skin are touched simultaneously the subject can report the difference only when the distance between them is not very less; otherwise the two points appear to be one. In the classical studies of dermal sensivity this phenomenon is known as aesthesiometric index.

Since Braille reading requires minimum tactilely perceptible difference, the study of two-point threshold is an important phenomenon for the blind population. Like many other findings the results reported on this problem are also somewhat inconsistent. Findings reported in Russian literature show that aesthesiometric index of the area of right index finger, which is used for braille reading (ungual phalanx), is almost twice that for the same finger in sighted subjects (Yarmolenko, 1959). Axelrod (1959) reported that braillist finds difficult to read with

1.24 his untrained finger, although with some practice transfer may occur. His results contradicted some earlier findings in which two point threshold of the right forefinger of the blind people was reported higher than that of the left or vice versa for the sighted people. On the other hand, he reported that ring finger of the preferred hand was poorer than left and right index fingers. A comparison of blind and sighted subjects on two point threshold revealed that early blind subjects had better acuity than sighted for right hand index finger, and that girls, on the whole, showed greater acuity than boys. One possible explanation for the difference in two point acuity may be that constant rubbing on raised points in braille reading makes tip of skin of fingers hard and leathary.

According to Jones (1975) some perceptual abilities in the blind may develop in relative isolation from each other. In other words, there may be within-modality effects which are relatively independent of whatever relationships exists between the senses. For example, blind people may sharpen their ability to acquire cutaneous sensivity which the sighted may never feel necessary. Also, perception of distance, perspective angle and relationships between objects are different in blind as compared to sighted subjects. Sato and Anayoma (1973) after standardizing a tactual perception test, found that their blind subjects were better than sighted on form, length and size subtests

1.25 but were equal on roughness and weight discrimination. Witkin et al (1968) reported that blind people score high on auditory embedded test and digit span, presumably due to sustained attention and show superior performance than their sighted counterparts.

Several studies reported that loss of vision retards some aspects of perception of blind people. Blind subjects were found inferior to sighted subjects in spatial coordination but they were superior in judging line to curve transformation (Pick, 1966). They also took more time to recognize embedded figures which means that what is preceived easily by vision may be a complex task for tactual perception. It is also well known that visual imagery helps positional relationship and in its absence sightless people give poor performance. Earlier it has been mentioned that blind children fail to strike proper balance between concrete, objective and spatial representation and speech and thought.

There has been several explanations for the perception of obstacles by the blind. Whereas some ascribe this phenomenon solely to heat sensations felt on the face, others attribute it to touch and smell together, and still others feel that these perceptions have an acoustic basis. Therefore, acoustic, thermal and tactile aspects together seem to contribute to hyperesthesia resulting in reducing

1.26 sensitivity for threshold of stimuli. Early studies by Supa et al (1944) report that the average distance perception sources of blind subjects were lower (i.e. they needed to walk closer to the wall for their initial perception of it) and their close perception scores were higher (i.e. they could not approach the wall so closely without collision). They concluded that auditory stimulation is both a necessary and a sufficient condition for the perception of obstacles by the blind and that the cutaneous surfaces of the external ears are not sufficient for the perception of obstacles.

Teachers of blind children often face difficulty in teaching them interrelationships between remote large objects that cannot be tangibly perceived or explained in words. In such cases blind children make use of their body cues relative to the reference points in space. The correlation between their body parts and imagined objects serve as a basis for their learning.

The orienting reflex of blind people is characterized by its orientation toward sound, the lack of a motor component, considerable emotional tension, and difficult extinction.

It has been suggested that whereas space may be best apprehended through vision, the perception of temporal duration may be more easily appreciated through auditory

1.27 stimuli. Hermelin and O'Connor (1978) reported that space was differently organized by blind than by seeing children. In their experiment they found that blind children always choose the temporal middle and deaf children the spatial middle, indicating that their input is confined to auditory and visual modalities, respectively. In their another study (1971) they concluded that modality of input was critical in determining not so much the physical as the conceptual organization of space. In the absence of vision audition and tactile-kinesthetic cues help them to organize their spatial judgements.

By and large, the experiences of illusions do not differ between blind and sighted people. Helen Keller reported normal illusion when she was given Muller-Lyer illusion.

SUMMARY

In the beginning part of this chapter a general description of the personality adjustment and development characteristics of the blind people was given with reference to their self, social learning, fears, play, mobility, language and intelligence. In the second part an analysis of perceptual characteristics of blind people was outlined with emphasis on braille reading, cerebral hemisphere dominance, two point acuity and space perception.

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CHAPTER 2

HUMAN MEMORY

While about two decades ago students of human memory were mainly interested in exploring relations governing acquisition, transfer, and extinction, contemporary students of memory are seeking understanding of how the mind works in registering and storing menmonic information and in the utilization of that information in a great variety of situations (Tulving and Donaldson, 1972). Although William James (1890) in the early part of this century did foresee the shift in the approach when he postulated the distinction between primary and secondary memory, it was not until the beginning of early sixties the application of information theory and nerve physiology caused revolution in the study of memory. And we now are more knowledgeable about our memory system than ever before: the sensory store in which the information lasts for about a second; the short term store with a limited capacity to hold material for a few seconds to act as a buffer (and hence also referred to as working memory); and lastly the one commonly known to psychologists for a long time, the long term store.

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2.2 HISTORICAL PROLOGUE

Detailed historical account of various viewpoints and researches on memory is available through several sources (Boring, 1957; Watson, 1971). In this section an attempt is made to give a brief introduction to the work done earlier on memory.

Atistotle (384-322 B.C.) maintained a position about mind which is similar to 'Tabula rasa' or a blank tablet of empiricist philosopher Locke. He believed that impressions of the percept are stamped in on it to serve as basis for memory. For him remembering was a spontaneous process of reproduction of past perceptions. Recall, on the other hand, is an active process of search to recover the past perceptions. Moreover, recall is based on the laws of association, viz., similarity, contrast and contiguity. After Aristotle's comments, the study of memory has basically lived through the debate over principles of association, both in British empericism and in British associationistic philosophy.

Prominent philosophers of the empiricist group are Thomas Hobbes (1588-1679), John Locke (1632-1704), George Berkeley (1685-1753), David Hume (1711-1776) and David Hartley (1705-1759). Hobbes (1650) advocated that sensation is the base for cognitive powers, not the innate ideas. Imagination and memory are nothing but fading sensations.

He conceived of unguided (free) and regulated (controlled) associations as the two broader categories. Locke (1700) believed that ideas are stored in memory by attention and depend also on pleasure and pain. In his writing on association he makes no reference to Aristotle and Hobbes and uses association only to explain errors of understanding. In 1709, Berkeley stated that contiguity of sensations is the basis of association of ideas. Hume (1740) discarded memory and imagination as faculties. He considered these as the way in which ideas work. In 1748, he distinguished memory and imagination, as the former is more clear and vivid than the latter. Moreover, memory is succession of original impressions, while in imagination impressions do not follow any order. He prescribed three laws of association, viz., resemblance, contiguity and causality. Hartley (1791) also held more or less similar views.

British associationistic group mainly consists of James Mill (1773-1836), John Stuart Mill (1806-1873) and Alexander Bain (1818-1903), but among them James Mill (1929) had made a strong plea regarding mechanical compounding. He stressed that all associations can be reduced to contiguity alone which is both successive and synchronous. For him association is a passive process, i.e. sensations occur in certain way and are reproduced in the same order as ideas. This concurrence of sensation is just mixture and no new creation. John Stuart Mill (1843) differed from his father

2.4 James Mill's view about association. For his father association is atomistic in nature, while for him it is active in the sense that mental events are compounded and give rise to something new which was not present in the original components. In 1865, he stated four laws of association, viz. similarity, contiguity, frequency and inseparability.

EBBINGHAUS AND BARTLETT: THE TWO GREAT EXPERIMENTALISTS

A marked leaning toward experimentation in psychology took place when physicists, physicians and physiologists like Fechner, Wundt, etc started the study of mental processes but it was Ebbinghaus who conducted the pioneering work in the experimental study of the processes of human memory. He not only deviced necessary methods, material, but used himself as the only subject of his study. In 1880, while carrying his research on memory, he was appointed as Dotzen at Berlin. Finally, in 1885 he published his research monograph entitled Ueber das Gedachtnis. In this original piece of his research, he had planned to study new learning to minimize the effect of previous knowledge. Therefore, he invented nonsense syllables which were homogenous and equally unfamiliar. His reservoir of nonsense syllables contain 2,300 trigrams in consonant-vowel-consonant fashion from which he drew the trigrams in random order to form his list to be learned. He borrowed

repetition from British associationism as a basis for experimental measurement of memory and fabricated the methods of complete mastery and saving by reading aloud the nonsense syllables at a rate of 2.5 syllables per second. He is best known for his classical curve for forgetting which shows the rate of loss at different intervals of time. He learned and later relearned 1200 lists. Each of these lists contained 13 syllables. Eight such lists were learned in one sitting. In several of the near replications his curve was found to be almost standard. He found that during first hour of learning forgetting occurs very rapidly (only 44 per cent saving found after 1 hour), and thereupon the curve flattens and little is lost between 2 and 6 day period.

Despite the merit of his experimental attack on a higher mental process like memory, Ebbinghaus was strongly criticised by Frederic Charles Bartlett (1932) in his classic book 'Remembering'. The major ground of his criticism is that by using nonsense syllables Ebbinghaus' study confined itself to a very artificial situation as it had hardly anything to do with the real life complexities of human memory. He also found that Ebbinghaus' experiments were too much stimulus bound as he ignored subjects' attitude and previous experience.

2.6 Bartlett contended that despite the complexity involved, meaningful materials like stories and passages of prose could also be studied in laboratory. His method, basically qualitative in nature, was called method of 'repeated reproduction'. For example, he took several reproductions of a North American folk tale entitled 'The War of the Ghosts' at various lengths of time. He carefully inspected the serial reproduction by a number of subjects and worked out certain general changes that took place, viz., omissions, rationalization, dominant details, transformation of details and transformation of order. Bartlett suggested that these changes take place as a result of the conflict between the material being remembered and schemata based on our past experience.

Bartlett's approach to the study of memory is certainly an important step to bridge the gap between laboratory and real life. However, even Bartlett's method is restricted in generality and does not provide accurate quantitative scoring pattern. Moreover, this approach did not attract much in the 30 years that followed the publication of his work. But there is a marked change in attitude toward Bartlett's approach to human memory in the recent years (Niesser, 1967; Oldfield, 1954; Miller, 1968; Guillian, 1968; Rumelhart et al, 1972). Modern psychology of human memory is trying hard to overcome these problems of over-simplification and complexity related to the study of human memory.

.7 MEMORY AND ITS MEASUREMENT

Simple impression that one may derive from the previous section on the historical account of the nature of memory studies is that learning through practice causes relatively permanent change in response (behaviour). This is referred to as the process of acquisition. It also exhibits that memory is a very closely related process to learning because any learned change is to be retained for a considerable period of time. In this sense memory is concerned with the durability of the learned changes (retention) and the process of retrieval at a given length of time. Forgetting, on the other hand, is just the other face of the same coin. Memory is indexed by the amount of information retained, while forgetting by the amount of information lost from the repertoire.

The central issue related to memory and forgetting has been the measurement of retention as a function of time after learning. There have been both quantitative and qualitative methods of measurement in practice. The quantitative method attracted more investigators than the qualitative methods mainly in view of achieving objectivity in measurement.

2.8 Quantitative Methods

Most important task for the scientific study of a higher mental process such as memory was the quantitative measurement of retention. A number of methods have emerged as a result of the effort to measure memory in the past century. It seems necessary to describe these methods separately in detail as all of them are not identical.

Saving method.

This method was used by Ebbinghaus in his classic study of memory. The task of the subject in this method is to learn the given stimulus material to the level of complete mastery. The subject is later required to relearn the same stimulus material after a given period of time. Retention is indexed by the saving obtained in total trials taken to relearn or by the saving obtained in total time taken to relearn. For example, a subject takes 10 trials/20 minutes to learn a test of 20 syllables to the level of complete mastery. After 2 hours he takes 5 trial/10 minutes to relearn the list to the same level of mastery. The saving may be computed by the formula given below:

$$\text{Percent saving} = \frac{\text{Trials/Time taken to learn} - \text{Trials/Time taken to learn}}{\text{Trial/Time taken to learn}} \times 100$$

2.9 This gives a saving of 50 per cent in the latter session to relearn. This method is still being used extensively.

Recall method.

Recall is the most comprehensive and popular method of memory measurement. The task of the subject in this method is to learn a stimulus material. Recall trial is one which falls immediately after the recall interval. Retention is indexed by the number of correct items on that particular trial. There are two different methods of recall, viz. free-recall and serial anticipation. In free recall method the subject is requested to recall all the items regardless of their order in the original list. In serial anticipation the subject is requested to recall the items of the list in their order in the original list. Another variation of the recall method is cued recall. In this method recall of only those items of the test is demanded which are related to a specific cue.

Recognition method.

Unlikely to the recall method, the measure of retention in this task does not require reproduction of correct response. Rather, the criterion or standard stimulus item is mixed with a sample of other items. The subjects' task is to indicate the imbedded standard stimulus item. A very common example is a multiple-choice question in which the respondent has just to make the correct choice.

2.10 Reconstruction method.

This method involves the subject basically to rearrange the disordered material in a previously learned order or design. An example of the task could be that the subject has to rearrange the item of a shuffled list in the previous order.

Different methods of retention yield different results which makes one feel that there are different memories. In fact, all the abovesaid four methods tap the same process, i.e. memory in different ways and to different amount. Luh (1922) studied retention of tests consisting of 12 nonsense syllables by methods of recognition, relearning, reconstruction, written reproduction (free recall) and anticipation (cued recall). His results presented in Fig.2.0.1 give the impression that these methods differ in the amount of retention. The performance for recall method is worst and for recognition it is the best. The validity of recognition method is less for three reasons: (1) certain number of correct choices will be just due to chance; (2) accuracy of recognition largely depends upon the homogenity of sample items or alternatives and (3) recognition scores are also influenced by the number of alternatives in the sample (Murdock, 1963). Despite this problem of validity, recognition method has its merit in providing evidence of retention when all other methods fail to do so.

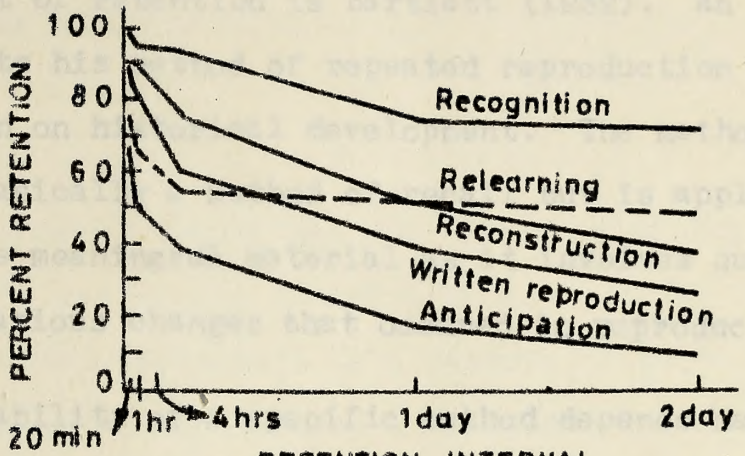
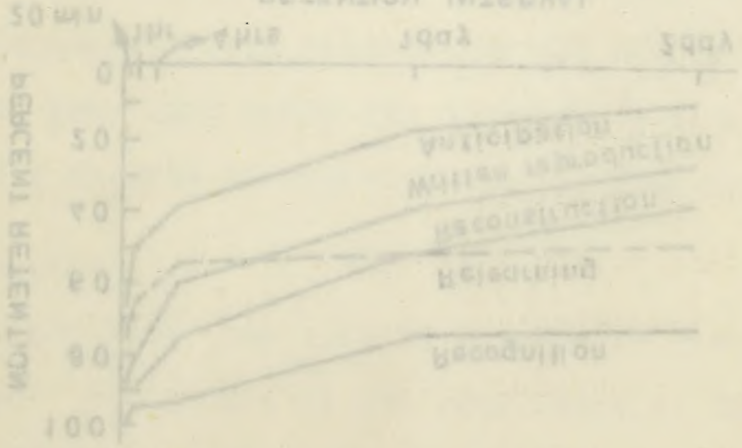


FIG. 2.0.1 CAMPARISON OF SEVERAL INDICES OF RETENTION OBTAINED FROM THE SAME SUBJECTS OVER THE SAME INTERVALS. Luh, PSYCHOLOGICAL MONOGRAPHS, 1922, 31, # 142: 22



.11 Qualitative Methods

The champion among the advocates of qualitative methods in measurement of retention is Bartlett (1932). An introduction to his method of repeated reproduction was given in the section on historical development. The method he followed is basically a method of recall but is applicable to many of the meaningful material as it involves qualitative analysis of various changes that occured in reproduction responses.

Applicability of a specific method depends mainly on the material being studied. The user of these methods is cautioned that one should never attempt to directly compare the retention scores of one method against other methods.

STORAGE AND RETRIEVAL

Memory consists of basically two processes, viz., storage and retrieval. Storage is the process that takes place after acquisition and before retrieval. Murdock (1974) defines retrieval as the utilization of stored material.

Storage

Wickelgren (1977) has categorized the fundamental processes of storage as constructive and destructive. Constructive processes consist of rehearsal and consolidation.

2.12 This section would deal mainly with the summary of the constructive processes. Decay and interference make the destructive processes and will be dealt in the section on the theories of forgetting.

Rehearsal.

As rehearsal bridges the gap between learning and storage, it has double function of acquisition and trace maintenance. Rehearsal is a process of periodic renewal of the short term memory trace which serves as maintenance mechanism. Rehearsal serves maintenance function much more effectively in retention of discrete items like words than in retention of continuous items like pitch of pure tones.

Consolidation.

Muller and Pilzecker (1900) putforth a consolidation hypotheses which is pseudoneurological in nature. They proposed continuation of the neural correlates of learning even after the termination of active practice. They believed that this continuation of neural correlates strengthens or consolidates the associations formed through practice. This proposition was given to explain the facilitation of performance after the end of practice (e.g. reminiscence). Thus, the process of consolidation is unconscious and beyond voluntary control.

2.13 A detailed review of various explanations regarding consolidation has been presented by Wickelgren (1977):

Increase in strength theory. Since consolidation causes facilitation of performance, it is reasonable to believe that it increases the strength of associations. There are certain reservations over this hypothesis. First, evidences of such reminiscence are very rare. Second, it could be better explained by other factors which are dealt in the following discussion. Moreover, plausibility of trace strength hypothesis is dependent on the assumption that associative memory is mediated by two dominantly different traces, viz., short term trace and long term trace (see Section V). It is stated that rapid decay of short term trace and increasing strength of long term trace occur simultaneously. This two-trace theory of consolidation is based on two subhypotheses. According to'independence' hypothesis short term trace and long term trace are established by separate and independent mechanisms. Time taken to consolidate by long term trace is more than that of the short term trace. Moreover, decay is slower for long term trace than short term trace. The 'conversion' hypothesis, on the other hand, states that consolidation is transfer of information from short term store to long term store.

.14 Decrease in fragility theory. Wickelgren (1974) proposed a consolidation theory which is consistent with a single trace theory of associative memory. He contended that, with consolidation, trace strength becomes less susceptible to disruption or loss from the factors that produce forgetting or retrograde amnesia, i.e. loss of memory due to **head injuries.**

Two dynamic properties of traces are strength and fragility (tendency of breakage). Strength determines the probability of recall and recognition. As a result of the reduction in fragility traces become less susceptible to decay and retrograde amnesis but not to associative interference. Consolidation is a reduction in fragility and not increase in strength. The reasons are that rate of forgetting decreases with increasing trace strength and age. Mathematical formula given on the basis of this theory explains retention function obtained for a variety of material over retention intervals ranging from seconds to two years (Wickelgren, 1975).

Retrograde amnesia phenomenon supports fragility hypothesis rather than increase in strength hypothesis. In retrograde amnesia most recent traces are lost regardless of trace strength (Russell, 1959). Support to the abovesaid hypothesis has also been drawn from a number of electro-convulsive shock and animal studies (Squire et al, 1975;

2.15 Weiskrantz, 1966). Wickelgren (1977) has also argued that drugs may increase forgetting by increasing decay through increase in metabolic or neural activity or by reducing the rate of consolidation (increase in trace fragility). In a number of animal studies it has also been shown that stimulants of central nervous system facilitate memory performance (McGaugh and Dawson, 1971). The more likely reason proposed is facilitation of consolidation.

Reminiscence.

Reminiscence refers to temporary improvement in memory performance after the end of practice. It is also known as the Ward-Hovland phenomenon or the Ballard-Williams phenomenon. The two names to the same phenomenon depend upon the delay in appearance of reminiscence after practice. The Ward-Hoveland phenomenon was observed between 2 and 5 minutes after the end of practice (Ward, 1937; Hoveland, 1940). Results of Ward's study appear in Fig.2.0.2 and of Hovelands study in Fig.2.0.3 . The Ballard-Williams Phenomenon, on the other hand, occurred after 2 or more days (Ballard, 1913; Williams, 1926). Results of Ballard (1913) appear in Fig.2.0.4.

Several explanations have appeared to account for reminiscence, and a brief summary of these reasons has been nicely given by Osgood (1953). Such improvement may be caused by simple positive growth, dissipation of inhibitions

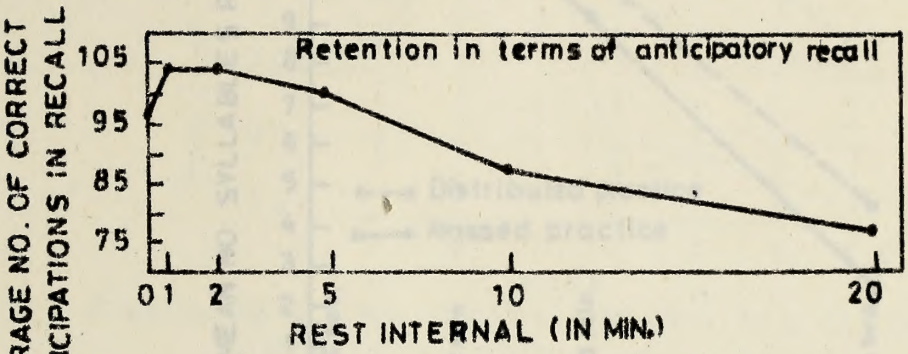
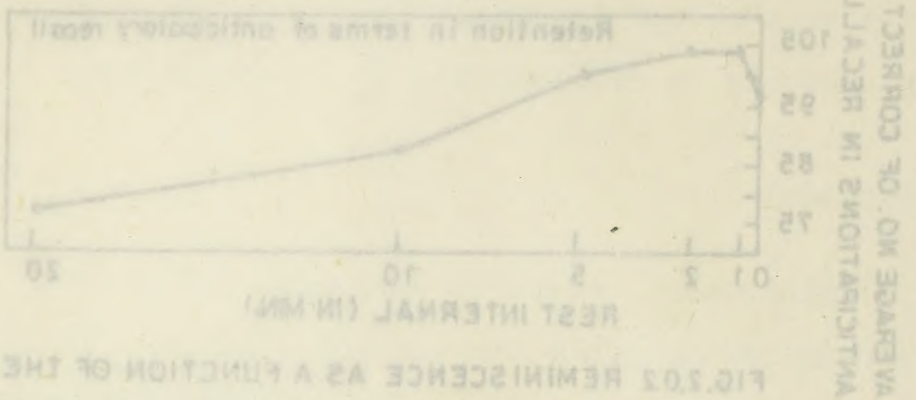


FIG. 2.0.2 REMINISCENCE AS A FUNCTION OF THE REST INTERVAL BETWEEN TERMINATION OF PRACTICE AND A RECALL TRIALS, AS MEASURED BY AVERAGE NUMBER OF CORRECT ANTICIPATIONS AT RECALL. WARD, PSYCHOLOGICAL MONOGRAPHS, 1937, 49, # 220:17


105
95
85
75
01
2
5
10
20
REST INTERVAL (IN MIN.)
INCREASE IN RECALL
ANTICIPATIONS
OF CORRECT

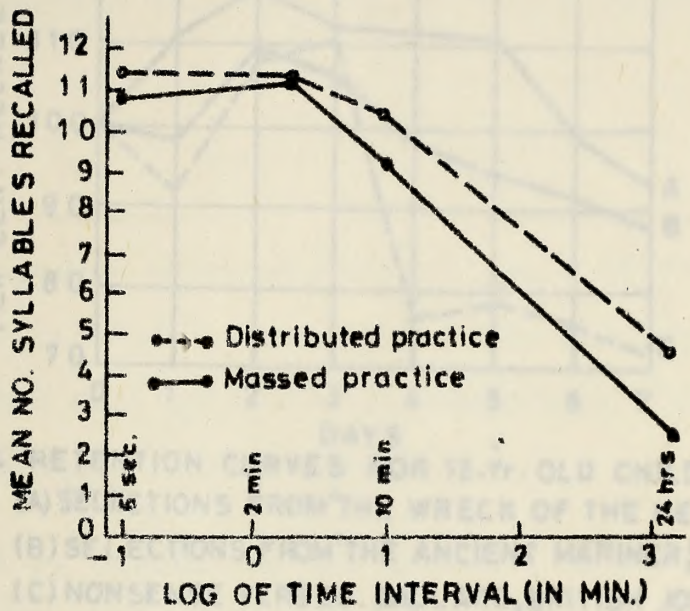
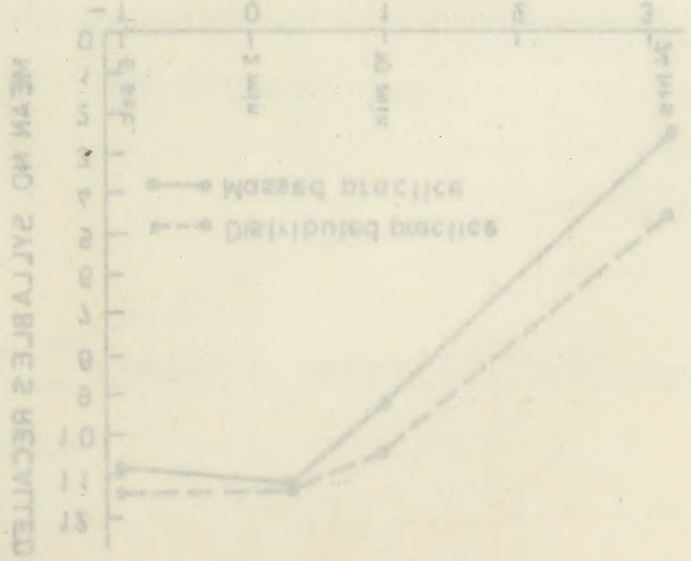


FIG.2.0.3 MEAN NUMBER OF SYLLABLES RECALLED AT VARIOUS INTERVALS FOLLOWING MASSED AND DISTRIBUTED PRACTICE TO A CRITERION OF ONE PERFECT RECITATION. NOTICE THAT THE RATE OF FORGETTING IS GREATER FOLLOWING MASSED PRACTICE. HOVLAND, JOURNAL OF EXPERIMENTAL PSYCHOLOGY, 1940, 26:575


Log of time interval (in min.)
Mean number of syllables recalled
Massed practice
Distributed practice

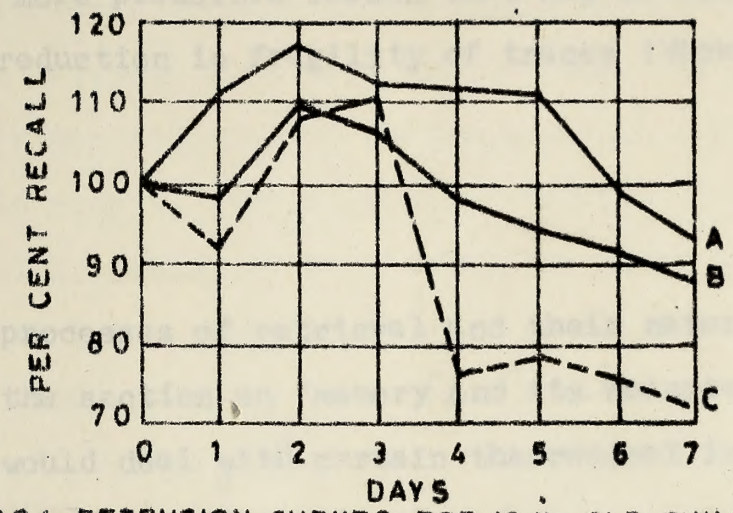
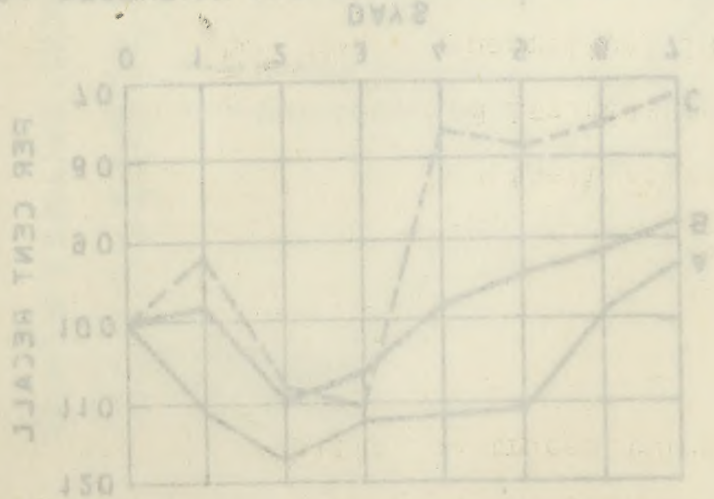


FIG.2.0.4 RETENTION CURVES FOR 12-Yr. OLD CHILDREN ON (A) SELECTIONS FROM 'THE WRECK OF THE HESPERUS'; (B) SELECTIONS FROM 'THE ANCIENT MARINER'; AND (C) NONSENSE VERSES. BALLARD, BRITISH JOURNAL OF PSYCHOLOGY, MONOGRAPHPH SUPPLEMENT, CAMBRIGE UNIVERSITY PRESS, NEW YORK, 1913, 1, # 2:5



2.16 during rest, differential weakening of remote associations consolidation of memory traces, or recovery from a performance decrement. A more plausible reason that may be added to this list is reduction in fragility of traces (Wickelgren, 1979).

Retrieval

Major processes of retrieval and their nature were discussed in the section on 'memory and its measurement'. This section would deal with certain theoretical issues related to the process of retrieval.

In an act of retrieving one operates on memory storage. He uses retrieval cues (stimulus) as input in this process. The resultant output is the input relevant memory trace. There are two theoretical views regarding the process of retrieval.

Direct access hypothesis.

According to direct access hypothesis retrieval of trace strength is a direct access process without any necessity of search or scanning of alternative traces in memory. It is also assumed that this process requires time. In this process the subject decides about the test item on the basis of the assessed strength. He compares assessed strength to some standard. He decides 'yes' if

2.17 the assessed strength is above the standard but 'no' if the assessed strength is below the standard.

For retrieval through direct access under recognition memory, it is assumed that retrieval process for one association is not affected by the presence of any other association in memory. For example, retrieval of an AB test association should not be affected by AC or DB association which are considered to be irrelevant for AB strength retrieval. Except the slight slowing down of rate of retrieval of AB test association, this hypothesis has been experimentally established (Wickelgren, 1967; Postman et al, 1968). In recall memory, associative interference is assumed even in direct access hypothesis at least among those associations that are above the recall threshold (Houston, 1968).

Search hypothesis.

This hypothesis proposes retrieval to be a process of serial scanning of various items in storage to find out the desired one. Sternberg (1966, 1969) putforth two distinct processes of search, viz., self-terminating and exhaustive. In the process of self-terminating search scanning ends whenever stored item is found in response to a test item. In exhaustive search process matching between test item and stored items continues for items stored in some set of memory locations. On the basis of evidences available to

2.18 him, Sternberg felt that retrieval in recognition memory is exhaustive rather than self-terminating. He also proposed, on the other hand, that retrieval in recall memory is a process of self-terminating search (see Section V for details).

FORGETTING

Forgetting is considered to be the other side of retention. It refers to the amount of previously learned material that has been lost or not retained. Theories of forgetting are various postulates about the processes that can account for loss in retention after learning. A few major theories of forgetting are summarised below:

Gestaltists Trace Decay Theory

Layman's viewpoint that impressions fade with time was reestablished by gestaltists. They influenced memory in its emphasis on the role of organization in memory and in its viewpoint of autonomous changes in memory trace. These ideas of gestaltists were an extraction from form perception studies (e.g. Wulf, 1922).

They disagreed with layman's conception of passive etching of traces which makes it gradually obscure. They proposed that memory trace is a dynamic process. It exists in the field of stress set up by perceptual and motivational

2.19 factors. Forgetting occurs as a result of spontaneous changes in memory trace during time.

In the classic work of Ebbinghaus trace decay was considered to be a possible mechanism of forgetting. There are various explanations of decay. First, time is a common factor in all instances of forgetting and it has been looked on as the basic source of forgetting. Second, forgetting has been accepted as a result of time related variables, e.g. disuse. Third, forgetting is assumed to be the result of physiological processes that cause fading of traces with lapse of time.

Behaviouristic Interference Theory

An alternative hypothesis to trace decay is associative interference. This term was first used by two German psychologists, Muller and Pilzecker (1900), in experimental analysis of behaviour. This was later introduced in America by Webb (1917). This theory proposes that learning depends upon association of stimulus and response. Activities around learning of criterion response interact with the criterion trace to change the response at recall. According to this hypothesis it is not the time that is important but the events that fill this period are the primary source of change in performance at recall.

2.20 A review of the five interference mechanisms that have been suggested by memory theorists is given below (Wickelgren, 1977):

Competition.

McGeoch (1932) is a major proponent of response competition hypothesis. He proposed that all forgetting is a result of competition among various responses of equally strong associations. A day-to-day confusion that occurs in spelling the word 'heir' is whether second and third letters of the word are ie or ei. This is a result of equally strong association for ie and ei in many of us. McGeoch tested recall for paired-associates using a AB-AC paradigm. Learning of AB list was followed by learning of AC list. When he asked the subjects to recall B associates of A, they also recalled C associates of A depending upon the relative association strength of C associates. He proposed that in such circumstances AC does not weaken AB. It simply competes when AC is stronger, C response will be made in place of B. Postman (1969) labelled it as independence-dominance hypothesis.

In these propositions it is contended that response competition, increases as a result of increase in retention interval.

2.21 Blocking.

Blocking is an interference mechanism in which learning of AC associations completely blocks the recall of B associates of A. Possibility of blocking has not yet been ruled out but it lacks clear evidences. Some evidence, though not very clear, for blocking was produced by Barnes and Underwood (1959).

Unlearning.

Melton and Irwin (1940) proposed that interpolated learning of AC list reduces the strength of the criterion AB list. This phenomenon of reduction in the strength of stored association was termed as unlearning. A strong support to this hypothesis has been obtained by Wickelgren (1976) who showed that interpolation of AC associations caused retroactive inhibition in a recognition test for originally learned AB associations.

Response suppression.

This interference mechanism was proposed by Postman et al (1968). They found that during AC interpolation C responses are primed by some selector mechanism. B responses of original AB learning either lose their active priming or are actively suppressed. It was supported by the fact that after 20 minutes of interpolated learning B responses of AB list spontaneously recovered from their suppression.

2.22 There is sufficient support for response suppression in recall but not in recognition (Postman and Stark, 1969; Slameka, 1966; Wickelgren, 1975).

Storage load.

In recent researches on short term recall storage load or the number of items in a list or the amount of information has also been suggested as an interference mechanism. In short term memory active rehearsal is considered to be very important process. With increase in the items in a list the probability of rehearsal of the items will decrease. It, in turn, will provide greater opportunity for decay.

Posner and Konick (1966) proposed an 'acid-bath' hypothesis. It suggests that increase in the number of traces stored increases 'acidity' in the store. Increase in acidity in the store makes the rate of decay of a memory trace faster.

It has been reported by Kool and Tripathi (1977) that short term recall shows advantage to auditory material only when the information load is low, but as the amount of load increases the auditory mode loses its superiority and the visual mode takes over (see Figure 2.0.5). This work is cited in details in Chapter 5.

However, storage load or 'acid-bath' hypotheses is similar to the unlearning mechanism in that in causes permanent loss of information.

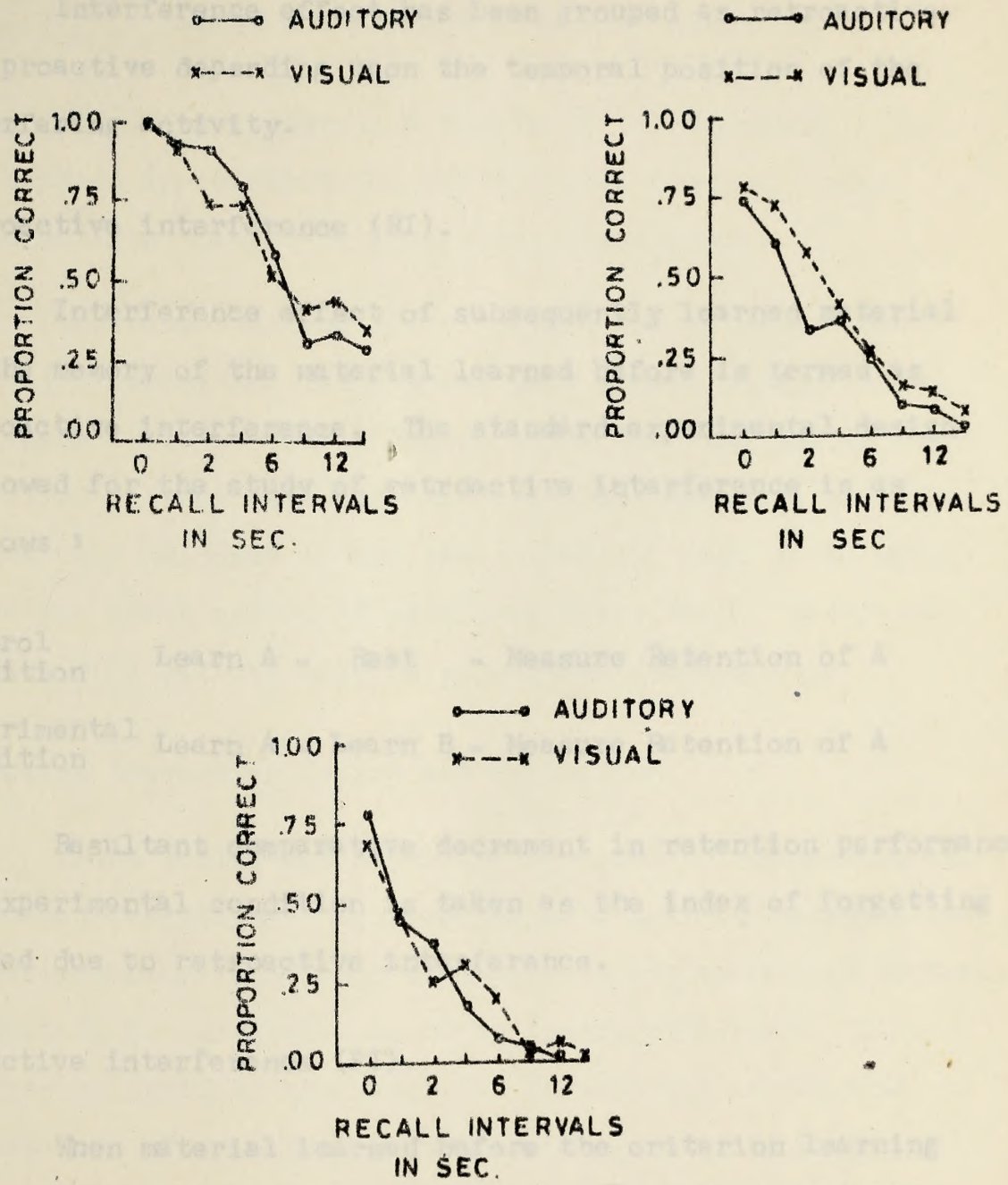
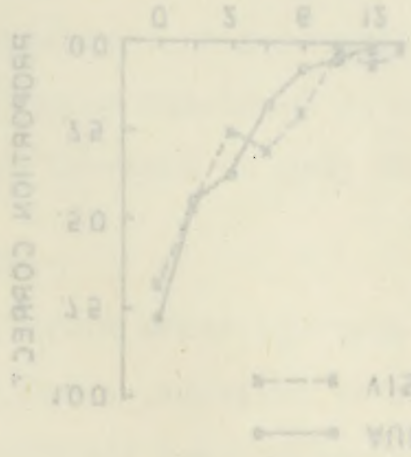
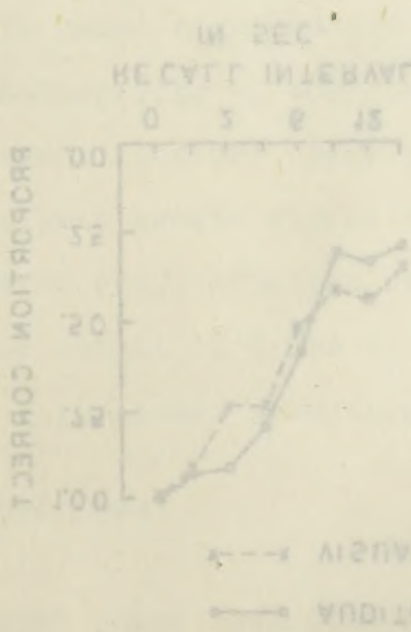
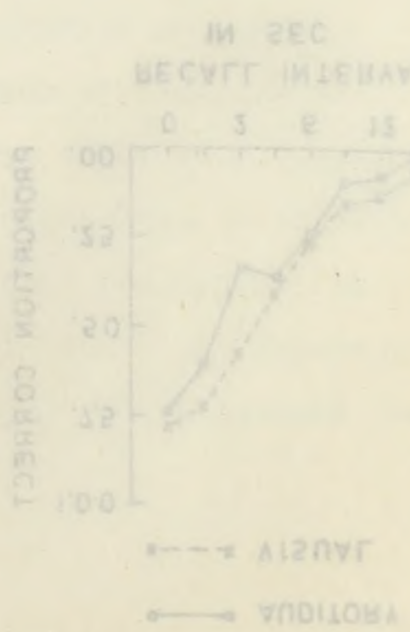


FIG 2·0·5. PROPORTION OF RECALL ACCURACY SCORES FOR CCC(a) ONE ROW (b) TWO ROWS AND (c) THREE ROWS MATERIAL UNDER AUDITORY AND VISUAL MODES OF PRESENTATION


RECALL INTERVALS
0 3 6 12
IN SEC
PROPORTION CORRECT
1.00
.75
.50
.25
VISUAL
AUDITORY


RECALL INTERVALS
0 3 6 12
IN SEC
PROPORTION CORRECT
1.00
.75
.50
.25
VISUAL
AUDITORY


RECALL INTERVALS
0 3 6 12
IN SEC
PROPORTION CORRECT
1.00
.75
.50
.25
VISUAL
AUDITORY

2223 Kinds of Interference

Interference effect has been grouped as retroactive and proactive depending upon the temporal position of the interfering activity.

Retroactive interference (RI).

Interference effect of subsequently learned material on the memory of the material learned before is termed as retroactive interference. The standard experimental design followed for the study of retroactive interference is as follows :

Control Condition	Learn A - Rest - Measure Retention of A
Experimental Condition	Learn A - Learn B - Measure Retention of A

Resultant comparative decrement in retention performance of experimental condition is taken as the index of forgetting caused due to retroactive interference.

Proactive interference (PI).

When material learned before the criterion learning causes decrement in retention performance, this effect is termed as proactive interference. In laboratory setting proactive interference is studied using the following experimental design :

2.24

Control Condition	Rest - Learn B - Measure Retention of B
Experimental Condition	Learn A - Learn B - Measure Retention of B

Resulting comparative decrement in retention performance in experimental condition is taken as index of forgetting caused by proactive interference.

Recently, Wickens (1970) showed how release from proactive inhibition takes place when fourth item of recall, say apple, belongs to a category other than the one to which the first 3 items belonged, say animals. However, when the fourth item belonged to the same category, that is animals, there was clear effect of proactive inhibition. Reference of RI and PI will be made in subsequent section also.

Execution Repression Theory and Motivation

Freud (1914) put forth the concepts of repression and motivated forgetting. By repression he meant a tendency to forget anything associated with ego-anxiety producing factors. Forgetting is considered to be an instrumental act. It becomes reinforcing when it helps in avoiding unpleasant experience. For instance, when one forgets an appointment with a person he dislikes he is reinforced because forgetting helped in avoiding humiliating experiences.

When college students were asked to judge their vacation experiences as pleasant or unpleasant and later to

recall these experiences, mixed findings were obtained. Both positive results, i.e. percentage of unpleasant items was low (e.g. Meltzer, 1930; Jersild, 1931; Stagner, 1931) and negative results (e.g., Cason, 1932; Menzies, 1935) were obtained.

The task in Alper's (1946) study involved learning of 20 items. Forty subjects were equally divided into two groups, viz. ego-oriented and task-oriented. Ego-oriented group was told that the task was a special intelligence test developed by Harward Psychological clinic. For task-oriented group it was put as impersonal routine work. A significant loss in retention was obtained only for task-oriented group.

Zeigarnik (1927) gave her subjects a variety of brief tasks in a series of 18 to 20. For each of the subjects half of the tasks were interrupted by the experimenter while half were allowed to be completed. It was found that a higher proportion of interrupted tasks were recalled than those completed. This phenomenon was called Zeigarnik effect and supported gestaltists view of motivation, i.e. they believe that in interrupted task condition goal tension continues which causes continuation of organization of memory traces and a tendency to complete the interrupted task. This effect has been supported in several subsequent studies (Brown, 1933; Rosenzweig, 1933; Marrow, 1938).

.26 INFORMATION PROCESSING APPROACH TO MEMORY: SOME NEW TRENDS

Information processing approach is mainly based on information theory and computer analogy. Before proceeding to the description of processing of information in memory, a brief description of nature of information will be given.

Information Theory

In a precise and specific manner information refers to a gain in knowledge (Shannon and Weaver, 1949) which increases with the increase in the amount of uncertainty in a given situation. The basic unit of information is bit (the boiled-down version of binary unit) which refers to fraction of alternatives that are reduced, not absolute numbers. In other words, it is amount of information when one of the two equally likely outcomes is specified (Abramson, 1963). For instance, there are two equally possible outcomes of a coin flip, viz., head or tail. If one decreases the outcome of a coin flip as 'tail', uncertainty is reduced with only one unit of information (bit) available.

Amount of information increases with the increase in the number of equally likely outcomes. Relation between the total amount of information (H) and the number of equally likely outcomes (N) is expressed as follows (Fitts and Posner, 1967) :

$$H = \log_2 N$$

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$$H = \log_2 N$$

.27 It means that information (H) increases by equal amount when N multiplies. The base of log is purely arbitrary but generally accepted as 2 because for every increase of a bit, N has doubled.

A very common confusion about information is that it is regarded as synonymous with meaning. It should be borne in mind that information refers only to the amount that is measured and this amount does not specify the context, purpose, truthfulness, etc. In other words, amount of information is related to how much one reduces the number of possible outcomes. Some of the very common concepts of information theory that are widely used in the study of memory are given below.

Redundancy.

Repeated information is called redundancy because no additional gain in knowledge is possible. However, it is very useful as an insurance against mistakes. A book, it is said, contains four times more material that is redundant but one cannot help it. For example, a formula is enough to understand a concept but it is explained in a variety of ways to assist the reader to grasp it firmly. All this clearly reflects on our basic efficiency as information handling system. In this context it is important to note that languages are highly redundant and that redundant material may lead to better performance in language just as in perceptual motor skills (Fitts and

.28 Posner, 1967). Earlier Miller and Selfridge (1950) had shown how the order of approximation to English relates to the amount of information that is transmitted. Since information is related to uncertainty, the lower order of approximation, which may be obtained by random arrangement of words from a dictionary,would carry more information than a higher order approximation in which occurrence of a few words leads us to predict subsequent words (redundancy).

Noise.

Noise refers to variability aspect in transmission. For example, the probability that P would be replaced by B in recall is higher than S or H because of acoustic similarity between P and P.

Other concepts like coding, chunking, etc. are discussed later in this chapter.

In the models of information processing human being is conceived as an information processing system which is analogous to a computer. Similarities between the human and the computer system are shown in Fig. 2.0.6 .

Before 1960's theorizing of human cognitive processes was very much limited to the concepts like stimuli, responses and association. The application of computer analogy helped psychologists in describing cognitive processes more effectively in terms of flow charts, inputs, buffers,

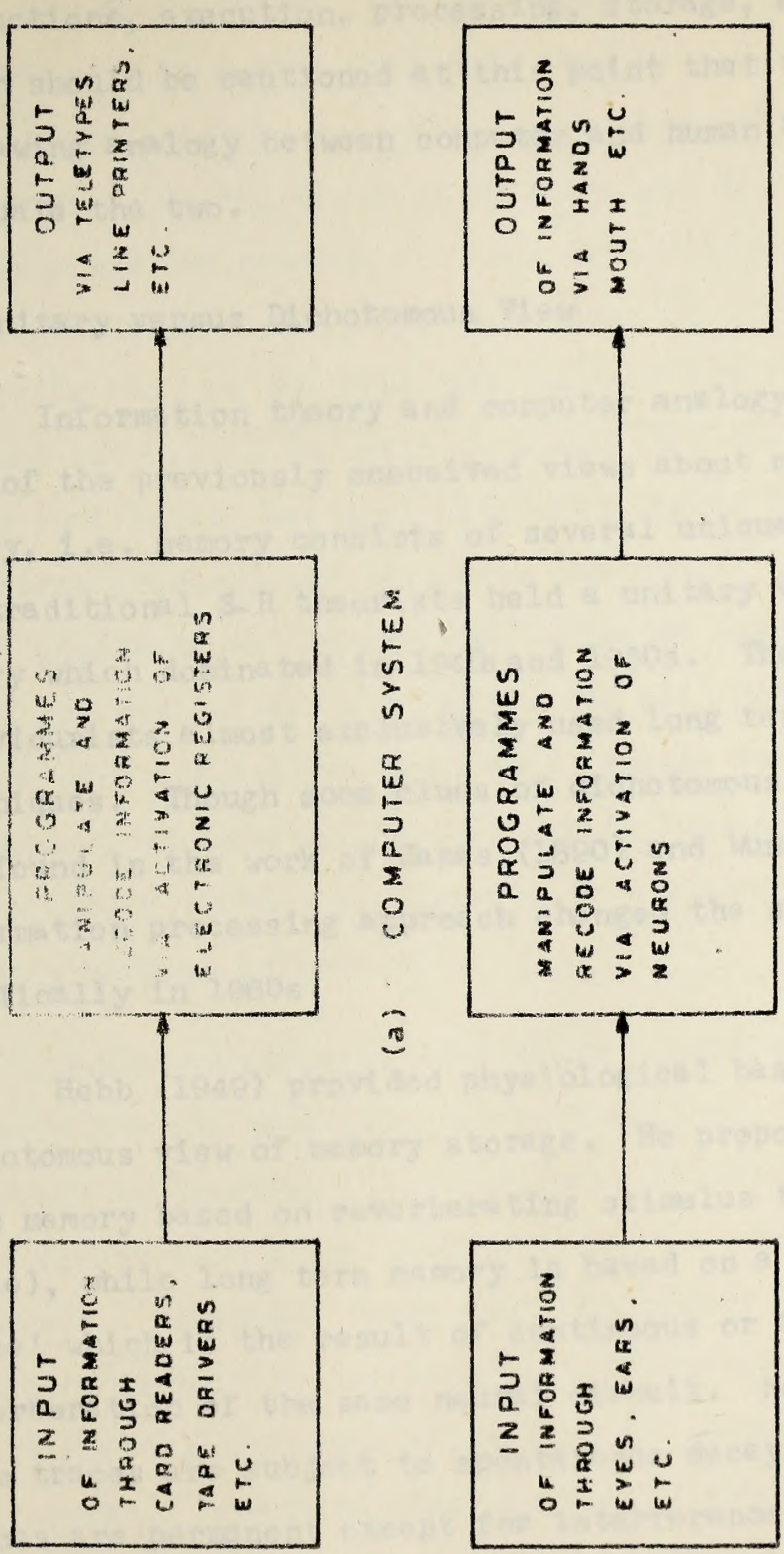


FIG. 2·0·6. SIMILARITIES BETWEEN THE HUMAN AND THE COMPUTER SYSTEM.

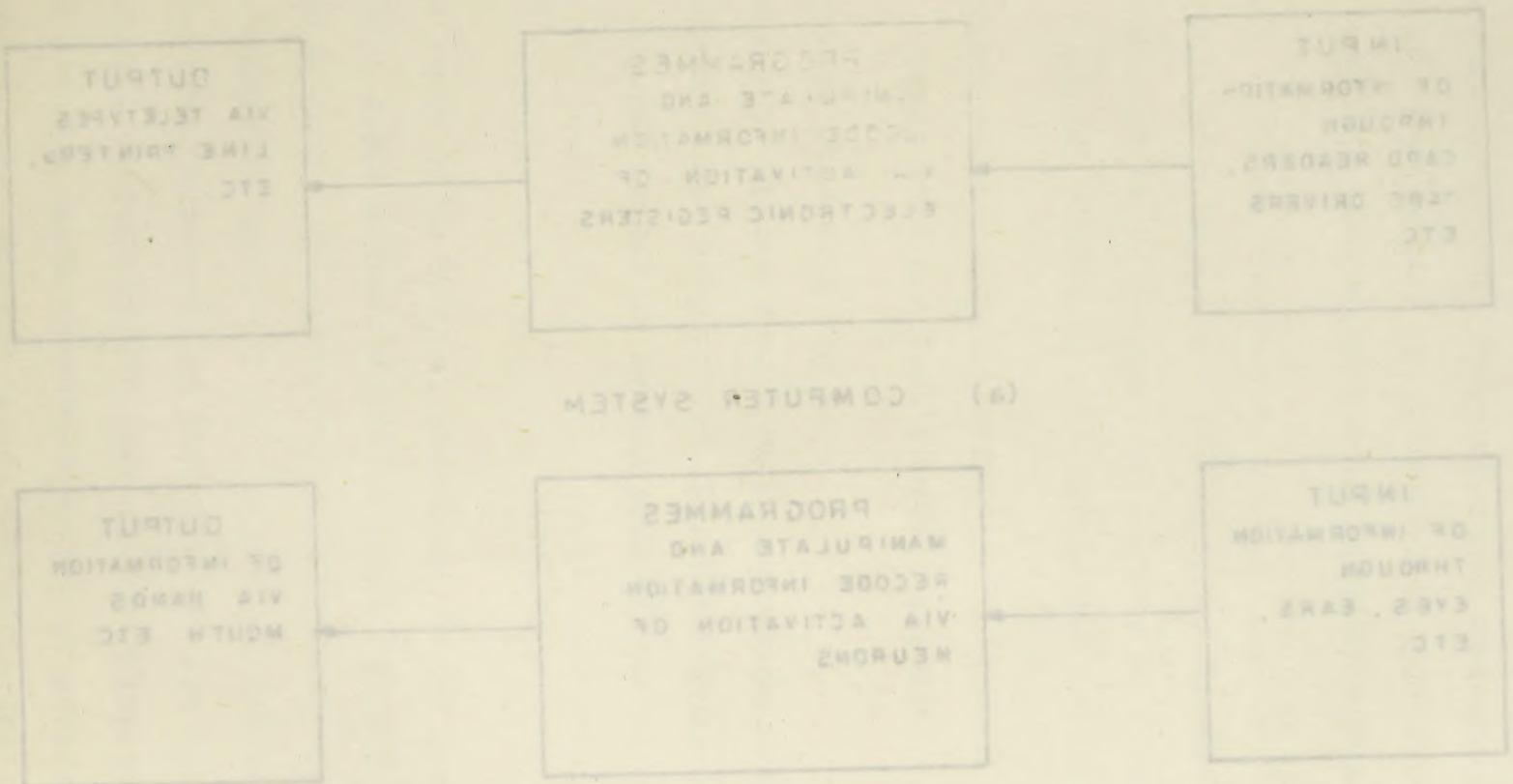


FIG 2.0.6 SIMILARITIES BETWEEN THE HUMAN AND THE COMPUTER SYSTEM

.29 instructions, execution, processing, storage, etc. The reader should be cautioned at this point that the purpose of drawing analogy between computer and human being is not to equate the two.

The Unitary versus Dichotomous View

Information theory and computer analogy strengthened some of the previously conceived views about multicomponent memory, i.e. memory consists of several unique systems. The traditional S-R theorists held a unitary view about memory which dominated in 1940s and 1950s. These behaviourists almost exclusively used long term memory techniques. Though some clues of dichotomous storage view are found in the work of James (1890) and Wundt (1905), the information processing approach changed the situation drastically in 1960s.

Hebb (1949) provided physiological base to the dichotomous view of memory storage. He proposed a short term memory based on reverberating stimulus trace (activity trace), while long term memory is based on a 'structural trace' which is the result of continuous or frequent reverberation of the same neural circuit. Moreover, short term traces are subject to spontaneous decay while long term traces are permanent except for interference from other long term traces.

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.30 Broadbent (1958, 1963) attempted to infer flow of information from behavioural data (and he is probably the first psychologist to describe cognitive functioning with a flow chart). On the basis of multichannel listening experiments he emphasized the concept of perceptual filter and channel capacity. Using a split-span procedure in which the first two digits came at the same time to left and right ear, followed quickly by the next pair and then the last, he showed that recall was most easy when digits on one ear were first produced and then from the other. In other words, people cannot attend two things at once and hence serial processing has to be made. He also held that people receive more information than they process but filter only that aspect of information that merits full attention. Work of Moray (1959) and Treisman (1964) shows how filter actively handles information.

Broadbent stressed that human beings have a limited capacity for the processing of information. Moreover, processed information is stored in a relatively temporary store (short term store), which is lost rapidly unless rehearsed. Rehearsal leads the information from short to long term store. He believed that forgetting in short term memory follows different rules than the forgetting in long term memory. Broadbent also proposed a sensory memory store which contained unprocessed sensory information for a second or so. This store has larger capacity than short term store, but forgetting in it is very rapid.

.31 Results obtained by Brown (1958) supported spontaneous decay of information in short term store. Brown also emphasized the importance of rehearsal for the transfer of information from short term store (STS) to long term store (LTD).

Peterson and Peterson (1959) presented their subjects 3 consonants and demanded recall after a period ranging from 3 to 18 seconds. They found nearly 50 per cent forgetting after 6 seconds and more than 90 per cent forgetting after 18 seconds and interpreted their findings in terms of decay theory as against the dominating associative interference theory of those days.

Some other evidences for dichotomous view have been received from clinical setting. Baddeley (1976) reported that Korsakov's syndrome is an alcoholic condition which results from excessive drinking and inadequate diet. He reported that patients suffering from this syndrome have gross long term memory defect, while immediate memory span is unaffected. Milner (1970) found that a bilateral operation on the temporal lobes and hippocampus for reducing epileptic seizures led to amnesia which is characterized as impairment of knowledge of current events, while long term memory remains unimpaired.

On the contrary, Melton (1963) has argued in his review that all memory traces are structural (permanent) and

.32 subject to interference. He proposed that short term and long term memories are special cases of a single system of memory which differ only in degree but not in kind.

A representative model of memory given by Atkinson and Shiffrin (1968) is given here to illustrate the characteristics of sensory short term and long term memory stores along with various control processes. This model is referred as the 'memory search and rehearsal buffer model' and is considered to be the most exhaustive one so far. The flow-chart of the model is presented in Fig. 2.0.7 . Three basic stores proposed in their model will now be discussed in detail.

The Sensory Information Store (SIS)

The sensory information store functions primarily at the level of the sensory receptors. This store has generally been studied in the visual system (Sperling, 1960). There is some evidence supporting its existence in other sensory systems also.

Consider the operation of visual sensory information store (i.e. iconic store). Eyes make a saccadic movement which is not smooth and continuous. These saccadic movements are divided into fixations and saccades (jump). Fixations refer to the periods during which eyes are still. Saccades are the quick eye movements separating the fixations. The

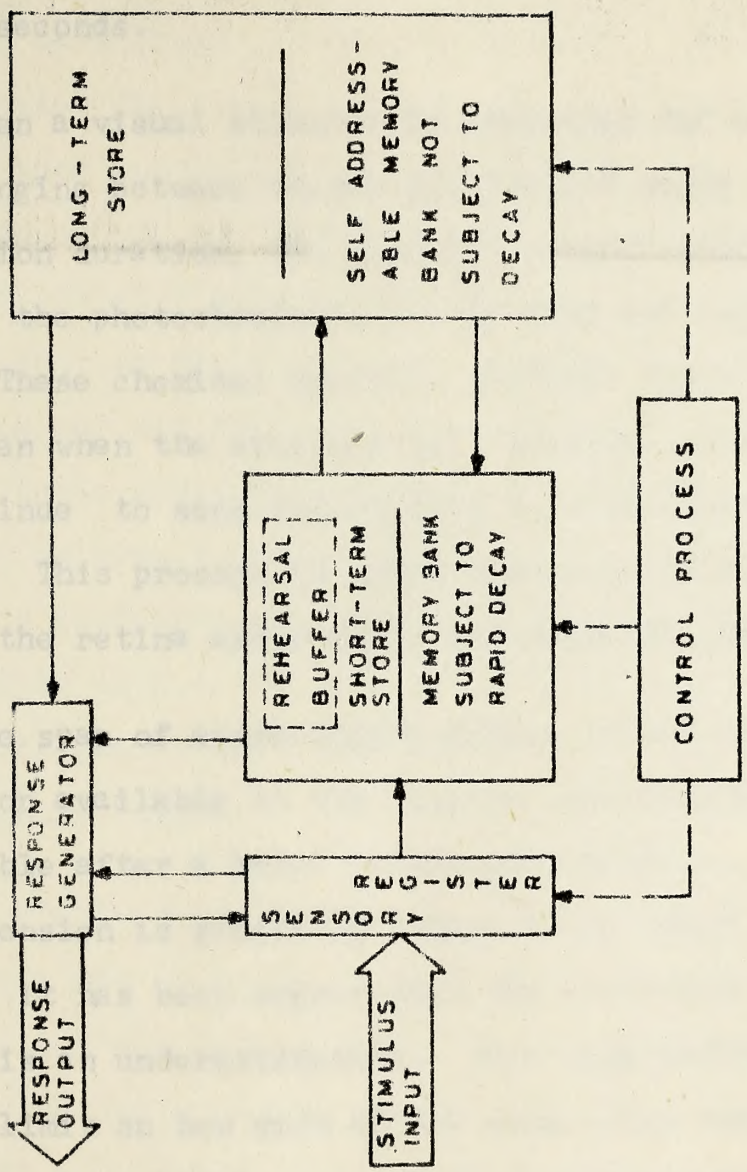


FIG. 2·0·7. MEMORY SEARCH AND REHEARSAL BUFFER. MODEL BY ATKINSON AND SHIFFRIN (1968)

FIG 2.0.2 MEMORY SEARCH AND REFRESH BUFFER.

MODEL BY ATLANTIC RESEARCH CORP. (1967)

.33 visual information is taken in only during fixations. Saccades occur at the rate of about 3 per second. Therefore, each fixation lasts for a period of about 300 milliseconds.

When a visual stimulus is presented for a very brief period ranging between 10-200 millisecond which is well below the fixation duration, the physical energy (stimulus) activates the photochemicals in the rods and cones of the retina. These chemical reaction continue for a brief period even when the stimulus has vanished. Meanwhile eyes continue to send information to brain about the stimulus. This process is ended when another stimulus falls on the retina and reverts the chemical reaction.

The span of apprehension refers to the amount of information available in the sensory information store which is available after a brief visual presentation. This span of apprehension is generally judged to be about 4-5 letters. Moreover, it has been argued that the abovesaid experimental estimate is an underestimation. This underestimation results due to a limit on how much of the seen items could be retained and not due to a limit on how much could be seen.

Sperling (1960) considered the generally accepted value of 4-5 letters (span of apprehension) as an underestimation of sensory information store. He deviced a partial report procedure to estimate the amount of

.34 information in the subjects' sensory store available at the time the stimulus was turned off.

Sperling presented his subjects 12 letters arranged equally in three rows for 50 milliseconds. The subjects were indicated the row to be recalled with the help of one of the three tone intensities, but had no idea which row was to be recalled before its presentation. On the average the subjects reported 3 out of the 4 letters of a row. This indicates that he had 3 letters available from each of the rows or one can say that the total number of letters estimated to be available would be 9 letters (i.e. 76 per cent of 12 letters). He also reported that a delay period of 1 second dropped the estimated recall to about 36 per cent, i.e. 4.3 out of 12 or 1.44 out of 4. The introspective report of the subjects showed that they were reading the items of the fading stimulus trace.

In short, Sperling gave an evidence to show that an iconic store has large capacity from which information decays at extremely rapid rate. Moreover, the information in this store remains unprocessed, and most of the information is lost before one attends to it and tries to retrieve.

Parallel to the abovementioned works on iconic store a modified method was proposed first by Moray et al (1965) to explore an echoic sensory information store (echoic store). Their method was further modified and extended by Darwin et al (1972). For the presentation of stimulus they employed

.35 earphones connected to one channel of a two channel stereotape recorder. For the manipulation of the direction of the sound stereo/mono switch was turned to mono. Turning the balance control switch to left, right or middle which changed the direction of sound to left, right or middle, respectively. A mixture of letters and digits were recorded on the stereotape. A string of the three different items were recorded on both the left and the right channels simultaneously. Another string of three items were superimposed on both of these channels. When the tape was played a subject wearing earphones could simultaneously hear a ~~strong~~ sound coming from the left, right and middle directions. A bar was flashed on the screen to indicate the string to be recalled to the left, right or the middle of the subject. Absence of signal indicated whole report immediately after presentation of the stimulus and the subject could recall about 5 out of 9 items. A 48 second delay deteriorated the recall to 4.25 letters. This experiment gives an underestimation due to serial presentation of items but echoic store can be inferred from it. The major difference between iconic and echoic stores seems to be in the time taken to decay. Information from iconic store is lost within 200 milliseconds to 1000 milliseconds but echoic forgetting is not complete until about 4 seconds.

.36 Transfer of Information From SIS to STS

This section would deal with the processes related to transfer of information from SIS to STS, e.g. pattern recognition and attention.

Pattern recognition.

If the information has to be of any real value, it must be transferred from sensory store (SIS) to some other store where meaning is attached to the information of sensory store. Transfer of information from sensory to short-term store (STS) is referred as pattern recognition. It means recognizing a pattern of sensory information as something meaningful.

The task of pattern recognition is performed via a feature detection analysis. A physical pattern 'A' is constituted of a complex array of informations or of a collection of elementary features. For instance, pattern 'A' is constituted of two straight diagonal lines, one horizontal line, three acute angles, two oblique interior angles, etc. Egeth (1967) has reviewed a number of articles that support feature detection.

Some concrete evidence of feature detection were also found in the physiological studies of Hubel and Wiesel (1959, 1962). They identified different cells in visual cortex which were responding to a specific kind of feature. For

37 instance, one specific cell to a vertical line and another only to a horizontal line. They considered these cells as elementary feature detectors.

Attention.

There are two systems that carry information from receptors to brain, e.g. (a) straight line sensory system and (b) reticular activating system.

Straight line sensory system. This is the primary information carrying channel. For instance, in case of eyes this system runs from the eyes straight through to the primary visual projection area in the occipital lobe. Permanent blindness is the result of the complete destruction of this system.

Reticular activating system. This system carries little information as such. By means of this system eyes alert the brain that information is being carried on the straight line system. Destruction of this system puts the organism into deep coma.

Sensory gating.

Once the reticular system has alerted the brain to attend a particular kind of stimulus, brain sends message to the other senses to cut down the volume of sensation coming through on these channels. This stimulus attenuating mechanism is called 'sensory gating'.

.38 The cocktail party phenomenon and shadowing.

Limits of attention or information processing capacity has been shown both in real life situation and in experimental situation.

For instance, imagine yourself in the middle of a crowded and noisy cocktail party with two simultaneous conversations going on, one at your left and another at your right. However, you find that you can pay attention to only one of the conversations at a time. In other words, you can pattern recognise only one of the conversations and transfer only attended portion to short term memory. The other information remains unprocessed in sensory store for a brief period and gets lost rapidly. This phenomenon has been referred as 'cocktail party' phenomenon.

The experimental version of this phenomenon is observed in experiments on 'shadowing' using dichotic listening procedure. In this procedure earphones connected to a stereo tape recorder is used to pass two messages to the subjects simultaneously, e.g. message is played to the subject through the left earphone and a completely different message is passed through right earphone. The subjects task is to 'shadow' the attended message. 'Shadowing' means loud repetition of message immediately after the presentation. It is generally agreed upon that

the subject processes remarkably little of the unattended message. Cherry (1953) found that the subjects were not able to report correctly the switch of language of the unattended message. Moray (1959) reported that subject failed to both recall and recognize the unattended message. Some other studies have shown that the subjects could report whether the voice of the unattended message was a male or a female. Reference to Broadbent's work was also made earlier in this chapter.

Short Term Store (STS)

In his model of memory Atkinson and Shiffrin (1968, 1971) proposed a short term store (STS) which has different properties than that of the SIS. The properties of STM are discussed below with suitable evidences.

Capacity.

A memory span procedure is employed to assess the capacity of STS. The subject is presented a string of letters or digits. The number of items in the string is varied from small to large. It is increased until the subject begins to make errors. Loftus and Loftus (1976) defined memory span of STS as 'the maximum number of items the subject can repeat back perfectly' (p. 43).

40 Wundt (1905) found span of immediate memory to be about 6 simple impressions. The simple impressions could be isolated lines, digits, letters, words, or arhythemic metronome beats. He also proposed that capacity of immediate memory can be increased using convenient grouping of elements, but his results depended heavily upon the introspective reports of his subjects.

Using objective methods Miller (1956) obtained results closely agreeable to that of Wundt. He reported the capacity to be 7 ± 2 but went further to claim that information (bits) per item did not affect the number of items in memory span. For instance, binary digits, letters, words. etc carry different amount of information per item but the number of items in the immediate memory span remains the same, i.e. 7 ± 2. To explain this phenomenon Miller coined the word 'chunk'. It is anything that has some unitary representation in long term store. Nevertheless, Miller contended that the capacity of STM span remains 7 ± 2 regardless of the information carried by the chunk.

Forgetting from STS.

Unrehearsed information of STS is forgotten quite rapidly. An experimental attempt to determine the forgetting over short duration was made by Peterson and Peterson (1959). They presented the subject a consonant trigram (e.g. LXB), which is well below the span of immediate

.41 memory to a subject for 2 seconds and recall interval was varied between 0 and 18 seconds. Rehearsal was blocked by the recall of the trigram. Their results are shown in Fig. 2.0.8 . It was found that recall was almost perfect immediately after material presentation but with delay of 18 seconds recall accuracy dropped to 10 per cent level.

It is clear from Peterson and Peterson's (1959) results that blocking of rehearsal is the major cause of forgetting from short term store. Keppel and Underwood (1962) examined the effect of prior activities on forgetting from STS using a Peterson and Peterson design. They found that performance decreased with increase in the number of trials. This forgetting was interpreted in terms of proactive inhibition. Pursuing this work further Wickens (1970, 1972) presented 6 trials of consonant trigrams to a control group, while to an experimental group he presented 3 trials of consonants and 3 trials of 3 digit numbers. He found the performance of experimental group improved on the fourth trial. This phenomenon was termed as release from proactive inhibition about which reference was made earlier in this chapter.

Form of information stored in STS.

We are now aware that information in STS is a faithful reflection of the original stimulus. Studies of short term store have shown that after pattern recognition raw sensory

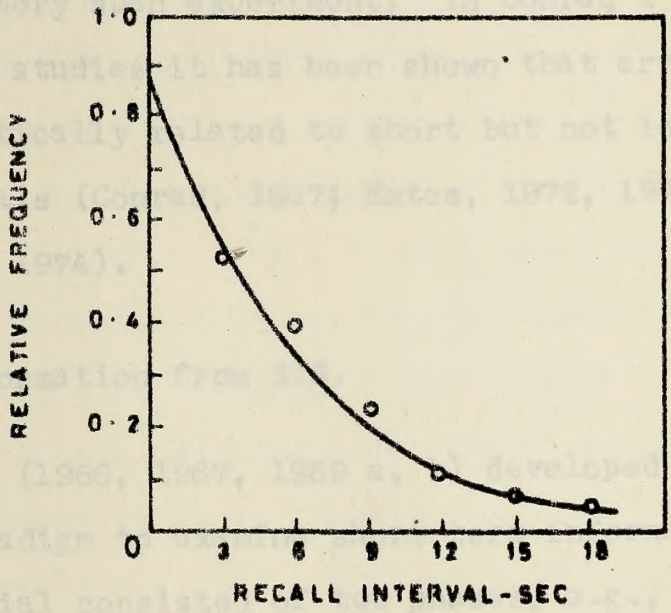
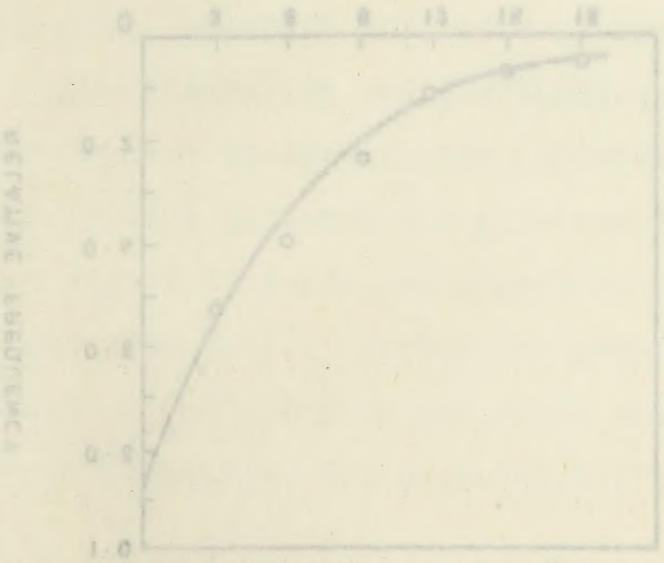


FIG 2·0·8. CORRECT RECALLS WITH LATENCIES BELOW 2·83 SEC. AS A FUNCTION OF RECALL INTERVAL.
(ADAPTED FROM PETERSON & PETERSON 1959)



42 informations of different kind are represented in auditory form. Therefrom the information stored in STS is basically auditory in nature. Support to this statement can be demonstrated with the help of Conrad's (1964) experiment which showed that errors are accoustically related to correct response in a memory span experiment. In Conrad's as well as other related studies it has been shown that errors tend to be acoustically related to short but not long retention intervals (Conrad, 1967; Estes, 1972, 1973; Bjork and Healy, 1974).

Retrieval of information from STS.

Sternberg (1966, 1967, 1969 a, b) developed an experimental paradigm to examine short term information retrieval. A trial consisted of two phases, e.g., storage phase and retrieval phase. In storage phase a memory set (a string of items), e.g. 3, 1, 7, 4, is presented to the subject. In the retrieval phase, a test item, e.g. 1, appears and his task is to report if the test item was present in the memory set. Sternberg found that the reaction time for the 'yes' or 'no' responses to be different but of particular interest was his finding that with increase in the size of memory set reaction time increases. This finding supported a sequential search hypothesis rather than parallel search. A linear relation found between the size of memory set and reaction time led him to propose a

3 serial exhaustive model of item recognition with the following events:

Stimulus → Stimulus encoding → Serial Comparison → Binary decision → Translation and response organization → Response

Thus, instead of suggesting subtraction method like Donders he believed in additive factor method in which each time an item is added in the set reaction time (RT) increased by about 38 milliseconds. In his 4 stage model he began with encoding of stimulus followed by its comparison with memory representation of the items. This search is serial and exhaustive and does not terminate when an item is available even though early in the search. Once activated, the set is completely searched. Following this scan comes a decision (yes-no) which is translated into a response.

Sternberg's work has received a great deal of criticism from several sources. It has been found that when an item is repeated in the positive set, RT to it are unusually short (Baddeley and Ecob, 1973); or if conceptual categories are available within a set, people scan only those categories (Naus, et al, 1972). But Sternberg replies to such criticism by maintaining that this does not mean that the search of the set was not exhaustive. However, Neisser's (1967) data ran counter to Sternberg's in which evidence for parallel processing is given. He required his subjects to

44 press a key (for recording RT) as soon as they searched a letter in a long list of letters arranged in 4 items per row. The typical search rate is about 10 lines per second which means about 25 millisecond per letter. This is very close to 38 millisecond reported by Sternberg. However, this search task, according to Neisser, does not require conscious perceptual analysis and makes a case of parallel processing as those involved in pattern recognition. Moreover, it is also possible that people can search several target letters together, not just each item one by one in a string.

The issue of serial vs parallel processing in memory is still being debated and some compromise is emerging in recent studies (Egeth et al, 1972; Anderson, 1976).

Long Term Store (LTS)

The third store proposed by Atkinson and Shiffrin (1968, 1971) is long term store which is characteristically different from two previously described stores. Long term store caught less attention of information processing theorists in comparison to the other two stores. One reason may be that there was sufficient amount of research already on long term memory while STM remained rather virgin. However, an attempt in this section would be made to distinguish the long term store from the short term store to identify the unique characteristics of LTM.

Capacity.

While capacity of short term store measured in terms of memory span is limited to 7 ± 2 chunks, there is no obvious limit to the capacity of long term store. Nevelsky (1970) defined long term memory span as number of items learned per trial. To compute this span he divided the number of items learned by the number of trials required to learn. In his experiment, he employed 4 lists of 2, 8, 64 and 512 items, respectively. The items were 3 digit numbers. Informations contained in the 4 lists of 2, 8, 64, 512 items would be 1, 3, 6 and 9 bits, respectively. Subject's task was to learn the material (lists) to the criterion of one perfect reproduction. The list of 512 items required 6.5 times as long to learn as the list of 2 items. Therefore, he concluded that long term memory span was sensitive to the amount of information per list.

Type of information.

There are sufficient evidences to suggest that information in long term store is basically coded in its semantic terms or in terms of its meaning (Anisfeld and Knapp, 1968; Baddeley, 1966, Grossman and Eagle, 1970). This conclusion was based on the fact that errors were semantically similar to the correct response when long retention intervals were employed in the procedure. For

instance, it is very likely that the recall of the original item CAR would be AUTO, VEHICLE rather than TAR or CAP.

Kintsch and Buschke (1969) examined the nature of information in long term store using interference as a base. They employed two lists containing either 8 pairs of synonyms or 16 unrelated words. Sixteen words were presented randomly which was followed by a probe item already present in the list. The subjects task was to recall the word that immediately followed the probe word in the original list. Results of this experiment are presented in Fig. 2.0.9 in which probability of correct recall has been plotted against its serial position. They found that semantically related words caused difficulty in recall only when presented early in list. In another experiment they presented acoustically related words in place of list of synonyms. These results are presented in Fig. 2.0.10 which shows that accoustically related words interfere only when presented recently in the list but not when presented early in list.

Both short term and long term stores possess acoustic and semantic informations. However, retrieval process of short term store is primarily sensitive to acoustic information. Retrieval process of long term store, on the other hand, is primarily sensitive to semantic information.

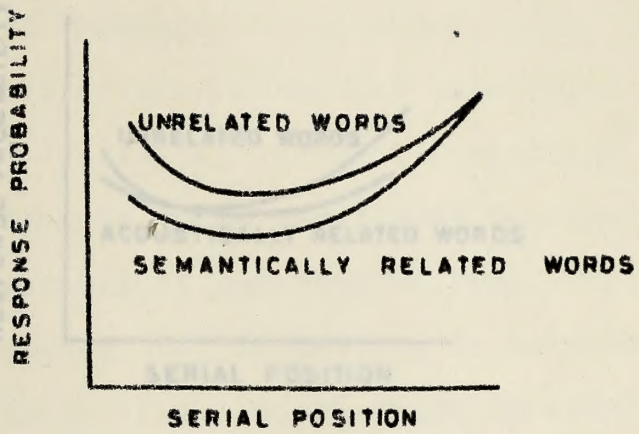


FIG. 2·0·9. RESULTS OF THE KINTSCH-BUSCHKE (1969) EXPERIMENT. PROBABILITY OF CORRECTLY RECALLING WORDS AT VARIOUS SERIAL POSITIONS FOR UNRELATED VS SEMANTICALLY SIMILAR WORDS.

(AFTER KINTSCH & BUSCHKE, 1969, FIG. 1 AND 3, RESPECTIVELY. COPYRIGHT 1969 BY THE AMERICAN PSYCHOLOGICAL ASSOCIATION)

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(AFTER KINTSCH & BUSCHKE, 1969, FIG. 1 AND 3, RESPECTIVELY. COPYRIGHT 1969 BY THE AMERICAN PSYCHOLOGICAL ASSOCIATION.)

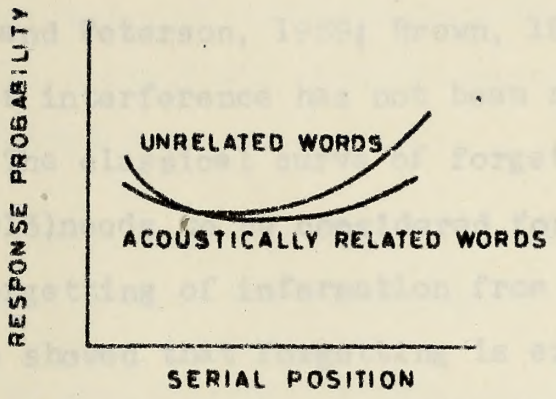


FIG. 2·0·10. RESULTS OF THE KINTSCH-BUSCHKE (1969) EXPERIMENT. PROBABILITY OF CORRECTLY RECALLING WORDS AT VARIOUS SERIAL POSITIONS FOR UNRELATED VS ACOUSTICALLY SIMILAR WORDS.
(AFTER KINTSCH & BUSCHKE, 1969, FIG. 1 AND 3, RESPECTIVELY. COPYRIGHT 1969 BY THE AMERICAN PSYCHOLOGICAL ASSOCIATION.)

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(AFTER KINTSCH & BUSCHKE, 1969, FIG. 1 AND 2. RESPECTIVELY. COPYRIGHT 1969 BY THE AMERICAN PSYCHOLOGICAL ASSOCIATION.)

.47 Loss of information.

Peterson and Peterson (1959) reported in his study of short term store that about 90 per cent of material is lost within 18 seconds if the information remained unrehearsed. In short term studies there is heavy emphasis on the importance of extermely rapid decay of traces (Peterson and Peterson, 1959; Brown, 1958) though a possibility of interference has not been ruled out (Melton, 1963). The classical curve of forgetting obtained by Ebbinghaus (1913)needs to be considered for the proper examination of forgetting of information from long term store. The curve showed that forgetting is extremely rapid in the first hour (e.g. saving score drops to about 43 per cent). The curve comparatively flattens afterwards and even after 31 days saving score did not drop more than about 22 per cent. These results suggests that decay from long term store is very slow and total information from this store is rarely lost.

As against the emphasis of trace decay in short term forgetting, interference has been considered a major source of loss of information from long term store. A list of 10 CVCs was to be learned by the subjects to the criterion of one perfect reproduction in an experiment conducted by Jenkins and Dallenbach (1924). Retention intervals of 1, 2, 4 and 8 hours were filled by ordinary working

activity or by sleeping. CVCs were better recalled after the intervals of sleeping than after the waking.

ORGANIZATIONAL PROCESSES IN MEMORY

The fundamentals of the principles of organization emerged in Gestalt psychology in form of the laws of perceptual groupings, e.g., similarity, nearness,etc. While summarizing the Gestaltists view of organization Postman (1972), narrated 4 features:

1) Mnemonic organization is largely established by the initial perceptual events to be remembered.

2) The form of organization is determined by the relation among the component units, i.e. total configuration.

3) Long term recall depends on the temporal stability of memory traces laid down by the experiences.

4) Retrieval of traces is determined by the similarity between these traces and current stimuli.

Although their concept was elaborate and unique it could never gain experimental support because Gestaltists lacked methods for measuring organizational activity. However, interest in the issue of organization never completely disappeared. The development of some new formulations for quantifying and measuring organization had revived the interest in the study of organizational

2.49 processes. This new formulation of organization was developed in the classical paper of Tulving (1962) in which he interpreted organization in terms of information processing theory. Before proceeding to the development of the area it seems reasonable to analyse the new concept of organization. Based on its various definitions, an attempt is made here to identify some prominent features of the term in the new perspective.

In its modern sense organization is considered to be an intervening process between input and output (Voss, 1972). It has been contended by Tulving (1962) that rehearsal is not capable of changing the basic capacity of store. Organizational processes that accompany rehearsal increase the capacity by increasing the amount of information (information load) per item. Therefore, the process of organization is useful for overcoming the inherently limited capacity of the organism for storing information.

According to Mandler (1970) organization is defined as mental structures. These structures lead to establish stable and consistent relation among items, events, features, etc. He defines structure as the particular modes or rules by which verbal material is organized. Thus, structure refers to a specific kind of organization. He proposes 3 types of structures, viz. categorical, serial and relational. Categorical organization is a subset

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.50 referring to a semantic category. Organization is serial when some syntax is implied. It is relational when some mnemonic device is used to relate two or more items to each other.

Organization has been defined by Loftus and Loftus (1976) either as an effort to fit the stimulus material into some preexisting logical framework or as an effort to create some new logical framework that groups the material into cohesive units.

Organizational processes, according to Tulving (1968), are governed by (a) semantic or phonetic relations among items (primary organization) and (b) the subjects prior extra experimental or intra experimental familiarity with the stimulus items of the list (secondary or subjective organization).

Organization is reflected in the systematization of input with regard to the order of items and stability of higher order units (Postman, 1972; Tulving, 1968).

Organizational Techniques

Given below is a brief review of some techniques that have been found useful for the organization of material into our memory.

51 Stimulus selection.

Attention of Underwood (1963), a distinguished researcher in the field of memory, was drawn towards the phenomenon of stimulus selection by his student, Mattock. In a paired associate learning situation the stimulus material employed was 8 pairs of items. A pair consisted of a trigram serving as stimulus and a three letter word as a response. In 62 per cent of the reports taken after learning it was made clear that the subjects used only first letter of the trigram as the stimulus to which to respond. Underwood termed the 3-letter trigram as a nominal stimulus and the first letter of the trigram in this context, a functional stimulus. Postman and Greenbloom (1967) reported that in case of difficult-to-pronounce trigram (e.g. XZC) the subject tend to select the first letter of the trigram as functional stimulus. Underwood et al (1962) found that the subjects selected colours over nonsense syllables as functional stimuli when the nominal stimulus was different nonsense syllable surrounded by different colours. In a number of other studies it has been shown that the component of the nominal stimulus which is selected as a functional stimulus is the most convenient cue for representation. Evidences for stimulus selection has also been found in animal studies (Kamin, 1969; Wagner, 1969).

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52 There are two theoretical positions on the issue of stimulus selection. The traditional view is that stimulus selection is a result of 'selective attention' to a specific component of the compound stimulus (Lawrence, 1963; Martin, 1968). It maintains the position that unattended components of the stimulus are ignored and are unavailable upon recall. The contemporary view about stimulus selection is against the traditional view in that all components are equally attended to or are available but the difference lies in the associative process or what one chooses to associate (Kamin, 1969 a; Rescorla and Wagner, 1972; Rudy, 1974). Evidences for both the views are available and it is very difficult to choose one of them. It seems reasonable to conclude that both views may serve as base of selection in different situations.

Stimulus integration.

Researches have shown that when the compound stimulus does not consist of functionally discrete units, the evidence for stimulus selection disappeared. In other word, when the compound stimulus was easy to pronounce trigram, it was represented as an integrated whole or unit (Postman and Greenbloon, 1967; Lovelace and Blass, 1968). This phenomenon was termed as stimulus integration.

.53 Coding.

When the subject changes the character of the verbal material into some more meaningful form, the process is referred as coding (Underwood and Erlebacher, 1965). For example, changing the stimulus material FML as FEMALE is known as coding. Such an advantage of coding in a paired associate learning situation was first reported by Underwood (1966).

Mediation.

Concept of mediation was given by early associationist. They contended that when two items are learned together (paired associate learning) one item tends to elicit another. However, in this situation when the items of the pair are not directly related, association can be developed using a third term which has no associative relation to the previous two terms (Reed, 1918). For example a pair DUP-TEZ may be learnt using 'deputize' as a mediator. Use of mediations has been reported frequently in current literature (Bugelski, 1962; Clark et al, 1960; Underwood and Schulz, 1960). Since these mediators were based on subjects previous language experience, they were termed as natural language mediators (NLM) (Adams, 1967). In an experiment conducted by Montague et al (1966) experimenter presented 96 pairs of high or low meaningful CVCs for a period of either 15 or 30 seconds. The subjects task was

54 to write their MLMs on a separate card. After a delay period of 24 hours the subjects were asked to recall the CVC response and their MLM for the pair. They found that MLM increased with presentation time and meaningfulness of the CVCs. They also found high correlation between the retention of MLMs and correct recall.

Facilitative effect of MLMs has also been shown on learning by Wood and Bolt (1968).

Chunking.

When a string of items contains many discrete items, these items can be converted into few unitary representations (chunks) to facilitate coding (Miller, 1956). For example, a string which contains F, L, S, M, P, U, J, E, as items may be converted into two chunks, viz., JUMPS and ELF. This process is known as chunking. It helps in increasing the capacity of STM in terms of information load.

Clustering.

Clustering is defined as grouping of randomly presented items at the time of recall in a free recall situation. Clustering emerged as an important phenomenon in the work of Bousfield (Bousfield, 1953; Bousfield and Sedgewick, 1944). In one of the experiments the list to be learnt consisted of 60 items drawn equally from four categories of animals, names, professions and vegetables.

2.55 The items were randomly presented to the subject who were given 10 minutes to recall as many items as they could. He found that subjects reflected a significant tendency to place items in cluster. Commonly used measure of clustering is repetition ratio (RR) which is obtained by dividing the number of consecutive items recalled from the same category by the total number of repetitions possible for the words recalled. The formula for computing repetition ratio (RR) is as follows :

$$RR = \frac{1}{N-1}$$

There are a number of studies that show that organizing according to category leads to improved recall (Cofer, 1967; Puff, 1970; Weist, 1972). Some studies have provided evidence of clustering of the items that sound similar (Bousfield and Wicklund, 1969; Dolinsky, 1972). Cohen (1963, 1966) suggested that both clustering and recall are more when the items belong to exhaustive categories than when the items belong to nonexhaustive categories. The abovesaid kind of clustering is referred as category clustering.

Associative clustering, on the other hand, refers to the situation where items of the list do not belong to some obvious categories but have some association and are grouped together on the basis of these associations, e.g. paper-pencil or car-wheel, etc. (Jenkins and Russell, 1952; Marshals, 1967; Walker, 1971).

2.56 Subjective organization.

Tulving (1962) studied recall of a list containing 16 apparently unrelated words using multitrial free recall paradigm. He found that at the first trial the subject could recall only 6 words but after 16 presentations he recalled 15 words. Moreover, subjects tended to recall the items in the same order on successive trials. Tulving termed this phenomenon as 'subjective organization'. It was noted that this tendency of subjective organisation strengthened over trials. Even in latter studies it has been argued that increase in recall is a result of increase in subjective organization (Mandler, 1967; Tulving, 1968), with,of course, certain exceptions (Carterette and Coleman, 1963; Postman, 1970).

Mnemonics.

Loftus and Loftus (1976) define mnemonic as a technique (often referred to as a 'memory trick') for organising information so that it can be more easily remembered.

'Method of loci' seems to be the oldest mnemonic system which has first used by a Greek poet Simonides by Cicero. As the story goes Simonides was invited to a banquet by Scopas, a nobleman. Simonides was called out by some unknown visitors. Meanwhile the building collapsed

2.57 and everyone in the building was killed and left beyond recognition. Simonides was able to identify the bodies with the help of his visual imagery of the banquet and remembering the position of each person. In this method of loci things to be remembered are placed at different locations and a pictorial image is formed. At the time of recall a mental walk is done to retrieve the item. Another mnemonic system is organization through rhymes, e.g. 'i' before 'e' except after 'c'. The area has now drawn the attention of experimental psychologists as a potential source to unfold the mysteries of human memory.

Imagery as a mnemonic technique has been studied by Bower (1973) in a paired associate paradigm. He employed too groups of subjects. One group was given instruction to learn the pairs by imagining a visual scene in which the two objects of the pair were interacting. The other group was a control group without any specific instructions. For example, given a pair DOG-CIGAR, the subject has to create a mental image of a dog smoking a cigar. Recall performance of the instructed group was almost twice as compared to that of the control group. There are other evidences to suggest that more unique and interactive images give better performance than those not so interactive (Bower, 1970; Lesgold and Goldman, 1973).

2.58 Narrative chaining was proposed to be a powerful mnemonic system by Bower and Clark (1969). He used a serial learning task in which half of the subjects learned the list by making a story around the words, while the other half had to memorize it without any chaining construction. In immediate reproduction, both the groups performed similarly. Using similar procedure 11 more tests were learnt. After the completion of 12th list, the subjects of the both groups were unexpectedly given the first word of the first list and were demanded to reproduce the complete list. Using this procedure recall of the remaining lists were also taken. It was noted at this point that experimental group could recall about 93 per cent of the words while the control group could recall on average only 13 per cent of the words. These findings show that facilitative role of narrative chaining in recall of words.

Organizational approach, however, seems to deal with the issues that are not easily dealt in terms of S-R associations or are cognitive in nature. But the current researchers do not see any necessary disagreement between two approaches (Postman, 1972; Voss, 1972). They attribute this difference mainly to the involved mode of thinking and the language used. Another important issue related to organization is the locus of organization. There are two views: one emphasizes that organization increases storage

2.59 (Tulving, 1962) and the other simply holds that organization facilitates retrieval (Tulving and Pearlstom, 1966; Weist, 1970). Postman (1972) bridges the gap by stressing that organization facilitates both storage and retrieval.

BIOLOGICAL BASIS OF MEMORY

In recent years several interesting biological explanations to account for memory have been offered. It has been proposed that short term memory has electrical basis and long term memory has chemical one. A nerve impulse is not electrically transmitted across a synapse. Action potential in the nerve fibre causes release of chemical substance which diffuses across the synapse and brings about chemical changes in the cell body of the adjacent neurone which acts like a stimulus to it and generates same movements of ions. Since conduction at synapse is slower than conduction along a nerve fibre, it suggests time consuming changes occuring at the synapse and has relevance to short term storage.

A popular explanation based on chemical coding system identifies DNA (Deoxyribenucleic acid), RNA (Ribonucleic acid) and protein as sources to account for long term memory. When RNA extracted from the brains of trained rats was injected into untrained rats, it led to better performance in the latter group (Babich, et al, 1965). Experiments which involve inhibition of RNA synthesis during

2.60 and immediately after training suggest that the formation of long term memory is prevented under such conditions. The main conclusion which emerges from such experiments is that RNA synthesis during training is necessary for formation of long term memory. Short-term memory, on the other hand, is not dependent on protein-synthesis. It is explained in several ways. Physiologists suggest that all or none action potentials circulating in neuronal pathways provide one mechanism but this has no direct evidence. Some of the evidences suggest that short term memory traces consist of nerve impulses continuously circulating in closed neuronal nets. It is also proposed that the relevant electrical signs of short term storage are to be found in slow potential changes arising from oscillations of synaptic potentials which are recorded as brain waves in electroencephalographs.

Studies on intra- and extra-cellular electrical phenomenon as well as the EEG during learning experiments show a clear change of EEG pattern accompanied by establishment of a new behaviour. As a result of electrical activity in neurones in learning situations the chemical composition of the cells' RNA changes or else electrical signals can 'switch on' the activity of certain genes to synthesize a special type of RNA which can work as an inducer of nerve connections.

2.61 The fact that electrical activity of nerve cells is accompanied by synthesis of RNA and protein does not tell us much about the part these molecules play in learning and memory. If two things happen at the same time this is never, by itself, a sufficient reason to believe that one is the cause of the other. The entire field of chemical memory transfer is controversial and only future research will unfold the mystery of this vital mechanism.

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CHAPTER 3

MOTOR MEMORY AND BLINDNESS

Vision is said to be richest in precision and details among sense modalities. When sighted people make their movements, they tend to rely on visual imagery for control and guidance even when they remain blindfolded. In absence of vision motor behaviour of blind people as a function of their remaining sense modalities becomes an interesting area of research.

Although researches in past two decades have produced considerably large amount of data on discrete movement of the blindfolded sighted subjects, little is known about how blind people organize and execute their movements. It is known that blind people rely on kinesthetic impressions which provide a temporal plan of various impressions to them. According to Scott (1969), counterpart of visual imagery for blind people may be called 'schema'. He defined schema as 'a series of haptic impressions and the temporal changes among them as a hand passes over an object' (p. 1027). Unlike visual stimuli which are given simultaneously, haptic stimuli are given singly. This schema is experienced as a sequence of variations in muscle

3.2 tension which are occasioned by the passage of one's fingers over the surface of some objects which are to be apprehended. Giving an example how a blind person experiences the shape of a tree, Scott mentioned that a set of tactile impressions beginning with the base of a trunk and extending on to branches, twigs and leaves occur to them. The neuro-muscular excitation of the arms and hands are then mentally strung together in time. When demanded the blind person reproduces the compressed tactile plan of his sensory experiences. This reproduction is known as a schema of a tree.

It seems necessary to distinguish perception of stationary objects in space and perception of one's own movement in space because sensory sources of the two are different. The source of sensation for stationary object lies outside the body, while for the body/limb movement in space it is generated within the nervous system in the form of kinesthesis. Introspectively determined sensation of movement is defined as kinesthesis. In neurophysiological literature the term kinesthesis has also been referred as proprioception. According to Sherington, (1976) proprioception is the information which is generated when the stimulus to the receptors are delivered by the organism itself. In other words, it is the action of the kinesthetic receptors and the sensory nerves involved.

3.3 NEURAL MECHANISMS OF MOVEMENT

There are some receptors which can pick up information about the movement and relay it to the brain. Two types of such kinesthetic receptors have been identified, namely joint receptors and muscle receptors.

Joint Receptors

Joint receptors are mechanoreceptors which respond to mechanical forces of tension, pressure, stretch and torque. These receptors can be classified into three major groups: golgi tendon organs, pacinian corpuscles and ruffini endings. It is believed that golgi tendon organs signal direction and joint position and the pacinian corpuscles signal movement acceleration and possibly detect very short movements. The ruffini endings signal the speed and direction of movements. These endings appear to be affected by muscular tension at the joint and therefore may also signal resistance to movement and perhaps discriminate between active and passive movement.

Muscle Receptors

Muscles are composed of extrafusal and intrafusal fibres. These join to form a unit which is attached to the bones of the body by tendons. Four to six intrafusal muscle fibres unite to form a long structure called muscle

3.4 spindle. Each intrafusal fibre consists of a central nuclear bag which is non-contractile, and two individually contractile polar regions which are separated from the nuclear bag by myotube regions. Nerve endings located on nuclear bag are called primary or annulospiral endings and the ones present on myotube region are called secondary or flower spray endings. The fibres that innervate annulospiral endings are among the largest and fastest conducting (100 meters/sec) in the body. Flower spray endings are smaller and represent slow fibres. Both these fibres are sensory in nature. The polar regions of the intrafusal fibres receive small gamma motor fibres which conduct at about 20-40 m/sec. The extrafusal muscle fibres and some intrafusal muscle fibres receive large alpha motor fibres which conduct at much higher rates (60-80 meters/sec).

Once the information is with the receptors, it is carried along nerve fibres or axons electrically and across synapses chemically to the spinal cord through its dorsal root along sensory nerve fibre. Before entering it meets cell body of sensory nerve fibre whose axon is comparatively short and ends inside the spinal cord where it forms a synapse with a second neurone called internuncial neurone. An axon from each internuncial neurone in its turn forms a synapse with a neurone of the third type called effector neurone or motor neurone. Some of the internuncial neurones connect with motor cells close to the point at which the

5.5 impulse enters the spinal cord and then to other regions in each direction. Some of them connect with the brain. Axons from the cell bodies of the motor neurones running upto the organs that respond are known as motor fibres.

For information to reach brain there are ascending tracts or sensory pathways in the white matter of spinal cord. The kinesthetic impulses travel in the gracile, cuneate and dorso- and ventro-spinocerebellar pathways. Gracile and cuneate terminate around cells in the respective nuclei in the medulla. The fibres from cells in these nuclei cross to the opposite side, ascend and terminate in the thalamus. The cells in the thalamus send fibres to the postcentral gyrus of the cortex (sensory areas). These two tracts give rise to sensations about the position of the limbs in the space and the direction and extent of movements whether active or passive. Dorso- and ventro-spinocerebellar pathways reach cerebellum via inferior and superior cerebellar peduncles. These convey impulses from the muscles, tendons and joints to the cerebellum.

From the cortex the impulses are sent to basal ganglia and lateral cerebellum wherefrom they are passed on to ventrolateral thalamus and thence back to motor cortex which can send commands to muscles to act. The sensory consequences of the movement reach motor cortex as well as Pars Intermedia (intermediate part of cerebellum).

3.6 The latter has a copy of efferent command sent to the muscles, whereby a comparison is made between the two and mismatch computed. This information is relayed to the motor cortex and modified command is again sent to muscles.

A REVIEW OF STUDIES ON MOTOR MEMORY

Researches on motor behaviour started at the end of nineteenth century. These researches flourished rapidly in the second quarter of the present century involving the studies on telegraphy, skills, components of motor abilities, motor development, maturation and motor skills, etc, as their major issues of research. According to Schmidt (1975 a), the reasons for this rapid growth of motor behaviour research were: support to motor behaviour research from the U.S. Armed Forces, development of learning theories and due importance to motor skill studies in industry and physical education. He viewed further that these researches were applied in nature and had the advantage of its immediate applicability. Later, the nature of these researches itself became a handicap to its growth owing to the lack of a precise definition of skill, nongeneralizability of the results obtained from applied researchers, poor scope to exercise experimental controls and lack of novel situations to examine the effect of new variables. In response to such problems, researchers have shifted their attention in recent years to basic research on motor behaviour.

3.7 A first step in defining a motor skill concerns with its precision. McGeoch (1927, 1929) initially believed motor skill to be an integration of well adjusted movements but he himself was not satisfied with his definition due to lack of its limiting value. A more precise definition of skill was given by Bartlett (1948) as a graded response which is basically initiated and controlled by an effector response. This definition of motor skill is generally agreed upon and serves as a base for recent researches. Adams (1971) has also emphasized the importance of simple graded movements to build a science of skilled behaviour.

There are two types of motor skills, i.e. discrete and continuous. These differ in the nature and retention properties (Baddeley, 1976; Schmidt, 1975). Discrete skill is defined as a movement with a discrete start and end. This kind of skill involves a particular response to a particular stimulus, e.g. switching a button in response to a red signal. Such skills show weakening of habit in due course of time. Continuous skills, on the other hand, refer to skills which have no specific start and end. These skills involve continuous movement to a varying stimulus, e.g. tracking activity, steering a car or flying a plane. Such skills show resistance to forgetting and little or no loss of habit even after fairly long delays. Retention of discrete skills have shown a great deal of

3.8 attention because of its greater susceptibility to forgetting. Therefore, the present review will be narrowed down to the area of discrete motor skills only.

Theories of Motor Learning

There are three basic theories of motor skills learning, i.e. closed-loop, motor programme and schema. The first has got sufficient experimental data in support, of course, with certain unresolved issues, while the other two still lack direct human evidences. A brief summary of these theories is presented below:

The closed-loop theory.

The closed-loop theory of Adams (1971) is basically a theory of instrumental learning of simple graded movements. This theory provides lot of scope for its testability. In his theory, Adams emphasized that the old concept of knowledge of results which involved motivational value should be revised to account for informations about the previous movement which could be used to correct further movements.

His two basic constructs of memory are the perceptual trace and the memory trace. Perceptual trace serves as a reference system which is used to compare the previous trace with the knowledge of results. This has also been referred to as an image or a neural model. This centre is responsible

3.9 for sending the specifications about the next movement to another centre called memory trace. Perceptual trace centre is used for the recognition of responses. Memory trace, on the other hand, is responsible for using the specifications received from the perceptual trace centre and issuing commands for the next movement. This centre is responsible for the recall of responses.

According to this theory, learning a movement is a sequence of stimulus, response, feedback from the response to the perceptual trace, its comparison with the past trace, and firing of a corrected movement based on the specifications issued from the perceptual trace centre. This state of error detection and correction is known as verbal-motor stage of learning of movement responses. When a person reaches a stage of mastery after prolonged detection and correction of error and he does not require feedback any more, this stage is called a motor stage.

The motor programme theory.

A rigid and outmoded theory of motor programme (Lashley, 1917) emphasized the existence of a set of stored muscle commands ever ready for action. Recently, Keele (1968) stated that motor command is a centrally stored sequence of efferent commands that is 'structured before the movement begins and allows the entire sequence to be carried uninfluenced by peripheral feedback' (p. 387). A modified

3.10 version of motor programme theory presented by Keele and Summers (1976) has accepted the role of feedback along with the existence of a motor programme.

According to Keele and Summer's modification, a motor programme centre is responsible for generating a pattern of neural out flows to the muscles which produces the desired movement sequence. Another important construct of this theory is 'template'. It is a comparison centre where an efferent copy of previously generated neural outflows is stored which is used to compare the kinesthetic and the other feedbacks produced as a result of the movement of the muscles. Results of this comparison are sent to the motor programme centre which now corrects the existing motor programme and generates modified neural outflows to masculature. Simultaneously, a copy of modified neural outflows is also sent back to the template. Thus a programme is stabilized with further practice.

The schema theory.

For his schema theory, Schmidt (1975 b) uses Evans' definition of schema: 'A schema is a characteristic of some population of objects, and consists of a set of rules serving as instructions for producing a population prototype of the concept' (p. 233). He has a similar notion of schema but defines it operationally. Major constructs of his theory are initial conditions, response specifications,

3.11 sensory consequences and response outcomes. Initial conditions consist of the information received from various receptors about the limb position in relation to the other body limbs and the space. Response specifications refer to the details of the movement command given to the muscles. Sensory consequences consist of actual feedback stimuli in the form of changes that occur due to the movement. These are exact copies of apparent informations provided to the response. Response outcome is the knowledge of results received about the correctness of the movement.

The above mentioned informations are stored after a movement task is performed. After a number of practice trials the subject abstracts the informations about the relations among the basic informations. Recall schema refers to the relationship between the past response outcomes and the past response specifications. Recognition schema, on the other hand, is the relationship between past actual outcomes and past sensory consequences.

A desired response is generated where desired outcomes and initial conditions act upon the recall schema which issues response specifications. Similarly, a recognition response is generated when desired outcomes and initial conditions act upon recognition schema which generates expected sensory consequences.

3.12 As reviewed by Schmidt (1975 b) both closed-loop and motor programme theories have their own limitations but even his schema theory lacks experimental evidences. Therefore, all the theories are still not accurate, though some have stronger empirical evidences than the others.

Retention of Movements

Motor memory studies deal with the various aspects of processing of kinesthetic informations. As per convention prevailing with verbal memory, studies of motor memory would also be described in two sections, i.e. long term memory and short term memory. It is beyond the scope of the present work to focus the discussion over the controversy concerning long term and short term memory. But it seems essential at this stage to describe the nature of the two as suggested in the area of the verbal memory and, subsequently to adopt it to the study of motor behaviour because the present work is concerned with short term recall of movements.

Baddeley (1976) has presented a clear cut conceptual picture of long term and short term memory. According to him, short term memory is an experimental situation which is characterized by limited input, a single learn-recall trial, and recall after a few seconds; while long term memory, on the contrary, is characterized by unlimited

3.13 input, a number of learning trials, and recall intervals ranging from hours to years. Moreover, short term memory is also considered as a short term store which is characterized by its limited processing capacity and primary auditory coding; while long term store is a system which has got unlimited capacity and everlasting codes based on semantics. A review of motor long term memory and motor short term memory follows.

Motor long term memory (MLTM).

Unlike the area of verbal memory, long term retention of discrete motor acts drew lesser attention. This may be the result of already emerged new conceptualizations of long term and short term memory in the area of verbal memory during that period (Broadbent, 1958; Brown, 1958; Peterson and Peterson, 1959). A typical example of long term discrete movement retention is an unpublished work quoted by Baddeley (1976). This study involved a typewriting task. Four conditions were formed using two lengths of lessons (1 hour and 2 hours) and two frequencies of lessons (once or twice per day). It was found that the 1 hour-once per day group was clearly superior and the 2-hour-twice per day group was worst. The other two groups performed in between and were not significantly different. This was indexed in both time taken to learn key positions and typing speed. Another feature of this study, which is more important in the present

3.14 context, is retention test of the skill after 1, 3 and 9 months. Poor performance of 2 hours-twice per day group continued to be poorer than 1 hour-once per day group and the former showed a high rate of forgetting.

Motor short term memory.

A rapid growth of research interest in the retention of discrete positioning movements over short time intervals is evident in the literature of the last two decades (Adams and Dijkstra, 1966; Posner, 1967; Posner and Konick, 1966). This growth could be attributed to some methodological conveniences and the desire to compare motor short term memory with verbal short term memory in order to explore the possibility of finding a similar set of principles and laws to attain economy in scientific description.

Though it is difficult to clearly demonstrate the boundary between verbal and motor responses, both differ in their fundamental nature. Verbal responses are conceptual or cognitive in nature, whereas motor responses are patterns of movement of limbs or of the whole body in order to achieve various objectives. Verbal and motor responses also differ in the nature of their error. Recall of verbal responses are categorically either right or wrong and, therefore, are 'all-or-none' in nature. Recall error of motor responses, on the other hand, is not categorical in nature and varies in degrees of accuracy. Therefore,

3.15 the error in the recall of movement is indexed as the magnitude of mismatch between the criterion and the recall movements. Research work on motor short term memory could be broadly reviewed as a search of informations subserving motor control and as seeking explanations for loss in storage of these informations. These studies also aimed at exploring the nature of coding mechanisms and the processes of storage. On the basis of their content these studies would be described under following sub-headings.

Movement informations. Early work on motor short term retention mainly involved study of simple discrete movements and no attempt was made to distinguish various movement informations. A study conducted long back by Scripture (1905) demanded reproduction of hand movements using finger tip along with the edge of a horizontally placed meter rule over short time intervals of 0, 10, or 20 secs and reported systematic loss in retention of movements. This finding was further supported much later using a simple slide positioning movement of the right hand (Adams and Dijkstra, 1966). In both the studies, reproduction of movement was demanded from the original starting point. There are other researches in which curvilinear movement was used with no attempt to isolate the movement informations (Stelmach, 1969 a, 1969 b). Recent studies on motor memory, however, have concentrated more on location and distance reproduction. In the former

3.16 the target point is the same as on the standard trials but the starting point is somewhere in the midway; whereas in the latter the same extent as on the standard trial is reproduced but the starting point is different.

The issue of isolating informations was raised on the basis of physiological findings which throw light on kinesthetic receptors (Mountcastle and Powel, 1959; Mountcastle et al, 1963; Skoglund, 1956) summarized earlier in this chapter. However, this classification of kinesthetic receptors does not show whether movement extent (distance) information is also registered through any of the kinesthetic receptor mediating location.

Psychologists attempted to explore this issue by isolating the movement informations. The first two attempts to distinguish location, i.e. reaching the same end point, and distance, i.e. reproducing the extent of movement, failed either due to the confounding effects of modalities or due to the insufficient manipulation of the informations (Posner, 1967; Posner and Konick, 1966).

Keele and Ells (1972) studied retention of locations by changing the starting position for recall and demanding the end point of the criterion target; and retention of simple movements in which both the informations were readily available for coding. They found that location plus distance condition yielded better performance than location alone,

3.17 and suggested that distance information was responsible for the difference in performance.

This contention could not get support in a study by Marteniuk et al (1972) which compared recall accuracy for isolated location and distance targets. This study employed a simple movement condition also in which location and distance informations remained clubbed together. They reported that recall of distance was much inferior to that of location, and location plus distance conditions; but the latter two were not mutually different. It was suggested that distance or movement extent information is not as precisely codable as location. This contention was also supported in subsequent studies (Hermelin and O'Connor, 1975a;Laabs, 1973; Marteniuk and Roy, 1972; Roy, 1978).

It has been reported by Roy (1978) that location information may be coded in terms of some motor-kinesthetic cues, e.g. muscle spindle information or muscle length/ tension relationship, while coding of distance information depends upon some nonmotor perceptual reference system like vision.

However, location vs distance controversy has not yet been resolved. Stelmach and McCracken (1978) have contended that location and distance informations are interdependent and coding of distance depends upon the relative amount of location and distance informations of a

3.18 given movement situation. This viewpoint is against the dual storage model of Laabs (1973).

Preselection. Preselection refers to the information about termination of a movement prior to the initiation of the movement. Voluntary movements, in which this information is available, are referred as preselected movements. Movements in which the target is assigned by the experimenter are called constrained movements.

Jones (1972) made a comparative study of voluntary, constrained, and passive movements. He reported that constrained and passive movements do not differ in recall error but both are inferior to voluntary movement recall. He argued that efference commands available in a voluntary movement are centrally monitored which could lead to superior performance in voluntary movement condition. Jones (1974) corroborated his previous study. He also employed backward counting task which interfered only in voluntary movement condition. He compared simple voluntary movements with voluntary extent information and reported that both the movements are precisely coded. Therefore, he suggested that both of them follow retention pattern of visually guided movements. It was also shown that additional proprioceptive feedback had no effect on voluntary movement reproduction. It was concluded that central monitoring of efferent (CME) signals to muscle is an essential and sufficient condition for the retention of movements over

3.19 short intervals. Marteniuk (1973) suggested that subject defined and experimenter defined movements are coded separately and the former is coded more precisely than the latter.

Stelmach et al (1975) have argued against CME hypothesis. This is based on their finding that preselected location was better coded than preselected distance despite the change in efference in preselected location condition. They also reported that recall of preselected location was superior to constrained (active) or passive locations which were not mutually different. Therefore, they concluded that preselection functions as a corrollary discharge mechanism, i.e., it generates an internal information flow from motor cortex to sensory area which presets them for anticipated consequences of the movement. They supported their contention with some physiological evidences indicating that there are cerebrocerebellar pathways which could function in the manner they suggested. Recall supremacy of preselected movements has also been reported in other studies (Kelso and Frekany, 1978; Stelmach et al, 1976).

Roy and Diewert (1975) studied the coding of preselected and constrained distances. Their reaction time data failed to support their hypothesis that preselected movements involve a more active encoding process which would require more probe reaction time than constrained condition. However, their absolute error data revealed that preselected (active) movements were better retained than constrained.

3.20 In a recent study, Roy and Diewert (1978) suggested that availability of information about the termination point of a standard movement prior to its initiation is responsible for better recall of preselected extent than that of constrained extent. Further, they suggested that movement relevant information (e.g. efference) is not a necessary component of preselection. They also observed that effect of preselection was not significant for constant error data (overshooting or undershooting of targets).

Roy (1978) has expressed his reservations on both CME and corollary discharge hypotheses offered as explanations for precise coding of movements. His findings suggest that the prior information about the termination of movement alone, not the act of preselection, is sufficient to cause precision in coding of movements. He contended that "... the prior information available in preselected movements may enable the subject to anticipate the sensory consequences of his actions, thereby facilitating the coding of limb position, probably in terms of muscle-spindle information. By taking into account the changes in starting position at reproduction, this augmented limb position could be used in reproducing extent. Although this process is similar to that proposed by Stelmach et al (1975) and Kelso (1977 a), it may not be dependent on the availability of efference as their feedforward mechanism is"

3.21 (p. 404). He also suggested the possibility that prior information may enable the coding of distance into a nonmotor store like vision.

Active versus passive movements. Movements are also classified as active and passive. This classification is based on the mode of movement presentation. In the active mode a subject moves his hand himself, while in the passive mode the subject holds the lever/slide passively and the experimenter moves the hand of the subject.

Keele and Ells (1972) attempted to distinguish between these two movements but failed to do so due to insufficient manipulation of experimental conditions but it was indicated in their constant error analysis that active movements tend to be underestimated more than the passive movements. It was reported by Marteniuk and Roy (1972) that reproduction of active and passive locations did not differ significantly.

Marteniuk (1973) reported that active and passive movements differed in degree of precision in coding. Active movements were more precisely coded than passive movements. But both movement conditions were similarly affected by interpolated activities. Jones (1973) suggested that active recall of the passive movement was poorer than its passive recall.

3.22 In a study of a simple reproduction task in which both location and distance informations were readily available, Kelso (1977 a) reported that active preselected mode exhibited better recall than passive preselected. It was contended that planning process based on preselection was not sufficient to facilitate coding. It also emphasized the role of efferent information generated by active exhaustion of the plan. Another finding of this experiment was that presence of a strategy (preselection) facilities generation of accurate efferent commands and both together cause better coding.

A comparative study of active/passive and preselected/constrained movements was conducted by Roy (1978) using only distance information. It was found that recall accuracy of distance information was equally good in preselected and constrained (with prior information) conditions. Moreover, in nonpreselected/constrained condition recall of active distance was much superior to that of passive distance. But recall accuracy of active and passive distances did not differ in preselected mode. This study suggested that advantage of efference cue is available only in the constrained mode. Preselection cue neutralizes the effect of efference and, therefore, recall errors between the active and passive preselected modes did not differ.

3.23 In a study of the role of active movement in the functioning of the hand as an effector and as a receptor, Roy et al (1978) found that as long as the subject decided the termination of a movement, an active movement during criterion learning is not necessary. On an object identification task, they found that passive movement of hand on the object yielded better performance than active. In this task, the active movement was found to be detrimental. This was explained on the basis of distraction caused by attention to efference. They concluded that active movement is not necessary in both effector and receptor functions of a hand movement.

Feedback. Providing additional feedback in the specific modality or through other sense modalities during learning of a movement generally enhances retention and causes resistance to forgetting. Trace strength is considered to be the positive function of the amount of feedback (Adams, 1971). Partial support to the abovesaid hypothesis could be obtained from a study which varied the levels of tension (0, 5 or 15) to see the effect of proprioception augmentation (Stelmach, 1968). It was found that augmentation of proprioception was advantageous on a 65° target position but not on a 25° target position. This study also suggested the possibility of a positive effect of this augmentation on the short targets with increased level of augmentation.

3.24 A comparative study of feedbacks conducted by Adams et al (1972 a) involved 5 feedback conditions, viz. auditory (A), proprioceptive (P), visual (V), all together (APV) and none (-APV). Substantial forgetting between 5 and 90 sec retention intervals occurred only under all feedback attenuated condition (-APV). The mean differences between following pairs were significant: APV vs. P, APV vs. -APV, V vs. P and V vs. -APV. In all these pairs, former condition revealed superior recall. It was also suggested that (a) additional feedback resulted in superior recall, and (b) vision was relatively more advantageous. Adams, et al (1972 b) reported that feedback change affected the performance at both low and high levels of practice. They suggested against the possibility of development of a motor programme and argued in favour of a closed-loop theory which stresses the role of feedback. Support for this contention was also obtained in subsequent studies (Adams, et al, 1977; Diewert, 1976; Stelmach, 1973).

Roy and Marteniuk (1974) compared learning performance under changed or interrupted feedback and same feedback conditions. They suggested that acquisition of fast movements is under control of motor programmes, while slow movements are under feedback control. Kelso (1977 b) studied neurological mechanism underlying memory for preselected location and distance informations. Finger movement was studied under joint/cutaneous feedback reduced

3.25 or unaltered conditions. Preselected distance was affected by feedback reduction but not the preselected location. He suggested that location was coded without joint feedback.

Contrary to the previous finding, Kelso and Frekany (1978) reported that availability of vision had no advantageous effect in reproduction of constrained movements. Moreover, presence of vision caused deleterious effect on the recall of preselected movement. It was suggested that for the advantageous effect vision should be present during both criterion and reproduction responses. Interfering effect of vision for preselected movement retention was explained on the basis of simultaneous attention to vision and execution of movement plan. This study also reported that visual information in preselected mode was spontaneously attended only in the absence of precuing. This finding was identical to that reported by Posner et al (1976).

Roy and Williams (1979) examined both specific and nonspecific effects of a pressure cuff technique of reducing feedback in the study of coding processes underlying preselected location and preselected distance cues. They employed normal feedback (N), reduced feedback (PC) and a control for nonspecific effects of ischemia (PCC) conditions. They reported that extent cues were better recalled than location. Moreover, feedback conditions had no effect on reproduction of location, while reduction of feedback affected the extent reproduction negatively. Non-specific

3.26 effects had no effect on extent reproduction. These findings were supported in both absolute and variable error analyses. They also reported that practice influences the effect of feedback reproduction. These findings suggest that (a) joint capsule and cutaneous informations are not responsible for signalling preselected limb position, (b) There may be use of afferent information from intramuscular receptor for the coding of location, and (c) location reproduction is determined by a control expectancy (preselection). Because movement length affects recall accuracy of distance but not location, it was also argued that location and distance may involve different perceptual and memory mechanisms. 'Location cue,' as they remarked, 'may involve some kind of substitutive mechanisms. Qualitatively different cues provided by different population of joint receptors may signal various joint positions' (p. 237). Movement extent, on the other hand, may be subserved by an additive mechanism, e.g. velocity/movement time information based on counting strategy. Another possibility for extent coding is the use of criterion end location as reference to adjust the distance by overshooting or undershooting.

Short versus long movement. Another important feature of movement is its magnitude. It was found that short movements are more precisely coded than long movements (Adams and Dijkstra, 1966; Hermelin and O'Connor, 1975a). Further, it was reported by Posner and Keele (1969) that

3.27 short movements were well retained over intervals of 10 to 20 sec, while long movements were spontaneously forgotten with lapse of time. Klapp (1975) suggested that short movements are predominantly programmed, whereas long movements are under feedback control.

It has been found that short movements are predominantly overestimated and long movements are underestimated. This classical effect is known as central tendency effect (Laabs, 1973; Hollingworth, 1909). Subsequently, this effect was re-established and termed as range effect (Elson and Wheeler, 1947; Peeper and Herman, 1970).

Effect of verbal labels. It is believed that the subject is not a passive recipient of information but he actively uses various strategies or plans to stabilize the traces. Recent studies show that providing verbal labels to the movements is very crucial in their subsequent short term recall. Stelmach (1974) suggested that verbal labels would help assimilation of new information for later recall.

Laabs (1976 a) investigated reproduction of a sequence of movements in response to a set of numbers which was repeated periodically to examine cumulative learning of the associated movement sequences. He suggested that learning occurred in the absence of extrinsic error information. This could be based on either the development of an internal error detection mechanism or a verbal labelling system.

3.28 It was reported by Shea (1977) that provision of relevant verbal labels to the standard enhanced reproduction accuracy and caused resistance to forgetting over time intervals. He also showed that attaching misleading verbal labels caused response biasing. It was suggested that retrieval of information from motor short term memory is a constructive process. Similar findings were also reported by Wallace (1977).

Intramodal and crossmodal transfer. A crucial area of particular interest in recent past is intramodal and crossmodal transfer of visual and kinesthetic informations. Two critical issues raised in this area are the processes of translation and crossmodal assymmetry. As this issue is more relevant to the experiments conducted on bimodal presentation of movement reported in Chapter 4, a review of literature on this issue has been given in that chapter.

Recognition in motor short term memory. As stated earlier Adams (1971) proposed a closed-loop theory of motor learning with two major constructs, i.e. perceptual trace and motor trace. Perceptual trace serves as a reference system. It is used as a comparison centre for the previous trace and the knowledge of results. Thus, perceptual trace serves the purpose of recognizing the traces. Memory trace, on the other hand, is responsible for issuing motor commands and serves as a mechanism for the recall of responses. There are some studies which attempted to validate the

3.29 'perceptual trace' and the 'memory trace' concepts of Adam's theory in which both recognition and recall responses were compared using the typical short term memory paradigm.

Marshall (1972) conducted parallel recall and recognition experiments to know if both of these are affected similarly by various variables. He reported that reinforcement increased both recall and recognition accuracy, while delays showed deleterious effect. His results supported Adam's (1971) closed-loop theory which predicts identical effects of relevant variables on recall and recognition of responses.

Kantowitz (1974) employed a 'same-different' recognition task. He reported that when mean area under memory operating characteristic (MOC), a non-parametric measure of observers sensitivity, was used as a measure of recognition, interpolated activity had no effect on the recognition of either kinesthetic or visual movements. This led him to conclude that visual and kinesthetic information do not involve separate memory codes. His results partially supported a distinction between visual and kinesthetic memory codes on the ground that judgement of same or different is dependent upon the context established by the modality of information. He found that for visual information it was easier to discriminate different trials irrespective of its type. When the information is kinesthetic, the different-over trials are better discriminated than different-under trials.

3.30 In a study of recognition short term memory of kinesthetically presented location and distance, Laabs (1975 a) reported that area under MOC did not differ for the two delay conditions but it was higher for the location (.808) than the distance (.680) information. This finding indicated that for the same level of recognition performance the difference between criterion and test movements should be larger for distance than location. Further, he reported that location targets were correctly recognized on 76.8 per cent of trials, while distance targets were recognized only on 64.6 per cent of the trials. A closed loop theory of motor learning was supported on the basis of the finding that delay affected motor recognition and recall differently. Adams (1971) suggested in his closed-loop-theory of motor learning that recall is based upon the memory trace while recognition depends on the perceptual trace.

Laabs (1978) investigated recall and recognition of preselected and constrained movements controlling the use of location and distance informations. In reproduction of constrained movements, reproduction of 'same' judgements did not differ from location and distance and there was no difference in the area of MOC for the two informations. Recall responses show better results for location than for distance. It was observed in recognition of the preselected movement that proportion of the same judgement did not differ between location and distance at conventional levels

3.31 of significance, while area under the MOC was significantly larger for location than for distance. Recall of preselected location and distance informations did not differ significantly. In short, these results show that constrained locations were recalled better (but not recognized better) than constrained distance; while preselected locations were recognized better (but not recalled) better than preselected distance.

Forgetting of Movements

Forgetting of movement informations is another aspect of movement studies. Forgetting could be defined as loss in retention. There are two major theoretical views concerning forgetting which have been summarized in this section. Empirical studies conducted to verify these theoretical positions also throw some light on the nature of peripheral and central mechanisms involved in the coding and storage of motor informations.

Trace decay.

Classical trace decay theory postulated that time lapse in itself is a primary and sufficient cause to account for decay of traces of the items that we learn. This theory does not necessarily refute the possible contribution of activities around criterion learning. Evidence for decay of motor items was gathered in a study which showed that

3.32 kinesthetic information was spontaneously lost over retention intervals of 5 to 120 sec, while increase in practice of criterion response caused resistance to decay (Adams and Dijkstra, 1966).

Adams' et al (1972 a) study which was reported earlier, proposed that a single learn-recall trial without any prior or retroactive interference would be a clean test of the trace decay hypothesis. This study revealed that spontaneous loss of memory trace over retention intervals occurred only under all feedback attenuated condition. Additional feedback were found to strengthen the traces. It was reported by Faust-Adams (1972) that an empty recall interval causes negative shift in constant error (undershooting).

Duffy et al (1975) studied recall of movements having both location and distance informations under 0, 2 or 6 sec paced distance rehearsal, location rehearsal, delayed recall and immediate recall conditions. Immediate recall conditions which were not mutually different. They concluded that the subjects relied primarily on distance information because spontaneous decay is the characteristic of the distance information. Moreover, long targets reflected more variable errors than short targets. They also showed that long delays between distance estimates caused more variable errors than short delays. Hangman (1978) found a non-significant effect of empty intervals on constant errors.

3.33 Interference.

Interference studies have either used an information reduction activity or some modality specific distraction. Information reduction activity refers to attention demanding verbal task, whereas modality specific distractor is an activity occupying specific modality of the criterion response. The inhibition effects of these distractors have been classified as proactive or retroactive depending upon the temporal sequence of the interfering activity. Response biasing is a special form of loss in retention and differs from the proactive and retroactive inhibition effects in the sense that it refers to direction shift (algebraic or constant error) in recall response as a result of surrounding activities of higher or lower magnitude or due to the time lapse itself. For the purpose of clarity in description these studies are categorized in following subsections.

Information reduction activities. These activities refer to cognitive tasks that demand attention, e.g. recording digit pairs, addition of digits and classification of digits into high or low and odd or even. Human brain is a limited capacity processor, and any task sharing attention causes distraction in the processing of a criterion response that requires attention.

3.34 An attempt to examine the effect of a distractor during the storage of motor activity was made by Schmidt and Ascoli (1970 a). Three distractors, i.e. constant trigrams, counting forward by '1s' and counting backward by '3s' were rehearsed while learning the criterion response. Rehearsing trigrams has no effect on recall. Backward counting by '3s' causes significantly more errors than counting forward by '1s'. This study added that proactive inhibition occurs due to distraction of the central processing capacity by prior verbal activities.

Information reduction activities were more frequently used in the form of interpolated activities and reported as retroactive inhibition. An attempt to examine the role of central processing capacity was made by Posner and Konick (1966) in their study of the retention of visual location and kinesthetic distance. Forgetting of both the informations was found over retention interval of 30 sec. Reproduction error of visual location was a function of interpolated task difficulty but task difficulty was ineffective for the retention of kinesthetic distance. It was suggested that visual location requires central processing capacity, while distance does not. It was also confirmed that both the informations are retained through imagery rather than verbal codes.

In an extention of the previous study Posner (1967) attempted to remove the confounding effect of modality and

3.35 information sources which were operating in the previous experiment. It was found that visually guided movements show little loss in retention over unfilled time intervals but attention demanding interpolated activities produce severe decrement in retention. Kinesthetic movements with no vision show spontaneous loss in retention over time intervals, and interpolated activities have no special effect. A similar trend was observed for location, and distance informations, respectively, but the effect was not significant.

There are studies which report that short movements require more central processing capacity than long movements (Posner and Keele, 1969; Stelmach, 1970).

In a comparative study conducted by Williams et al (1969) on verbal and motor short term memory, rest, recording, addition and classification were used as interpolated activities. It was reported that both verbal and kinesthetic distance informations are affected by interpolation and, therefore, require central processing capacity. It was also suggested that both may be differently sensitive to similarity and difficulty effects. This led them to propose that both tasks are based on independent neural-behavioural mechanisms.

Keele and Ells (1972) studied retention of location and distance plus locations informations. They reported

3.36 that there was no forgetting over 7 sec unfilled interval but 7 sec filled condition (classification) had adverse effect on recall of both information conditions.

Laabs (1973) used backward counting and spatial reasoning tasks as interpolated activity to block rehearsal. He reported that attention demanding tasks produce interference for location information which is maintained over unfilled delays but these interpolated tasks were found ineffective for distance information which is spontaneously lost with the lapse of time. He suggested a dual process model of motor short term memory which argues for at least two modes of storage. Distance is coded in a kinesthetic store which is lost spontaneously, while location uses a central memory code which is subject to interference.

It was reported by Jones (1974) that backward counting for 15 sec has deleterious effect on recall of voluntary movements but not on constrained and passive movements. Stelmach et al (1975) studied the effect of backward counting by '3s' on reproduction of preselected, constrained and passive locations. All the three conditions were negatively affected by verbal processing activity.

Stelmach and McCracken (1978) manipulated location by changing the time spent at target end point and distance by omitting, disrupting or augmenting the dynamic phase of the movement. They found that distance information was affected

3.37 by an interpolated information processing activity when the location cues were minimal. They also reported that reproduction of distance information was enhanced by repetition and location augmentation but disrupted by movement reversal. They suggested that coding of distance is dependent on location cues.

Roy and Kelso (1977) examined effects of movement informations (location or distance), movement lengths (short or long), time of cuing with respect to presentation of the standard (precuing or postcuing) and retention interval conditions. They failed to prove these hypotheses that precuing would facilitate coding of extent of a movement but not location. Absolute error analysis revealed no significant difference between recall of location and distance. Long movements show more absolute error than short. Interpolation of digit subtraction task resulted in more absolute error than immediate recall and 20 sec unfilled recall conditions, the latter two not being mutually different. Movement conditions x movement length interaction revealed that recall of location and distance information differ on long targets but not on short targets. It was also indicated in a movement lengths x retention interval interaction that a digit substraction task affected long movements but not short ones. Constant error analysis showed that long movements were largely underestimated while short movements were overestimated. Moreover, distance targets

3.38 were underestimated, while location targets were overestimated. A weak trend in variable error analysis was observed which revealed that precuing facilitated location but not extent coding.

Roy (1978) reported that recall of preselected and constrained distance targets differ only in immediate and unfilled delay conditions. Interpolated digit subtraction task negatively affected reproduction of preselected distance targets and the performance was equally bad to that of constrained distance targets.

Motor interference. Use of motor activities as distractors in motor short term memory studies was made with the view that if would occupy the specific modality of criterion information. These distractors were used both before and after the criterion learning. The study of proactive inhibition was emphasized by Stelmach (1969 a) who studied retention of three target positions (10°, 60° or 90°) over three retention intervals (5, 15 or 50 sec) using three prior motor activities (0, 2 or 4). He found that absolute errors increased with increase in number of prior activities and length of retention intervals. Amplitude of movement was not a significant variable, though evidence of proactive inhibition was available. Results were interpreted in terms of trace decay because increase in forgetting was found to be related with increase in retention intervals.

3.39 Using response similarity as a variable, Stelmach (1969 b) produced evidence for proactive inhibition. Three levels of similarity ($\pm 5^{o}$, $\pm 15^{o}$ or $\pm 25^{o}$) were used in this study and retention intervals were the same as those used in the previous study. Recall errors increased with decrease in similarity and delay in recall. This similarity effect is reverse to the one that is found in verbal short term memory studies. While comparing the two, it should be borne in mind that the nature of responses differ for the two. Support for proactive inhibition effect was also recorded in other studies as well (Ascoli and Schmidt, 1969; Williams, 1971).

There are a few studies on proactive inhibition which have failed to draw support in favour of proactive inhibition. In a study of motor short term retention of linear task conducted by Montague and Hillix (1968), each trial consisted of 4 training repetitions and a recall test. In this study two retention intervals (5 or 80 sec) and three intertrial intervals (5, 20 or 80 sec) were employed. Mean absolute errors were influenced by retention intervals but not by intertrial intervals. This study failed to get proactive inhibition effect and the findings were explained in terms of trace decay hypothesis.

The task in Schmidt and Ascoli's (1970 b) study involved learning and reproduction of positions along a trackway with retention interval fixed at 10 sec. The

3.40 intertrial intervals were 10 and 20 sec. Each subject received 10 trials. Proactive inhibition was found absent in this study also and therefore it was argued that intertrial interval was not a relevant variable for proactive inhibition in motor memory.

It is observed from the above mentioned studies that intertrial interval is not a sensitive variable for the study of proactive inhibition but number and magnitude of activities immediately before criterion learning produce proactive inhibition effect. It could be also noted that these studies involve mainly simple reproduction and no special attempt was made to isolate the movement informations.

Studies of retroactive inhibition are richer than proactive inhibition studies. Boswell and Bilodeau (1964) studied retention of lever positioning responses after an interval of 28 sec. Four groups were formed combining pencil retrieving (Yes or No) and lever returning (by E or by S) tasks and these tasks were used as interpolated activities. It was found that lever zeroing response did not interfere, while retrieving pencil from the floor caused significant loss in retention. Stelmach and Wilson (1970) used a kinesthetic information reduction activity and reported that retention of location targets was a function of both retention interval and the information reduction activity. This study also indicated that short targets require more attention than long targets. Retroactive

3.41 inhibition effect was also observed by Patric (1971) in a study of short term motor retention using movement as an interpolated task.

Retroactive inhibition effect was negated by Stelmach and Barber (1970) who used antagonistic responses as an interpolated activity. Herman and Bailey's (1970) study of short term memory (24 sec) for discrete force responses compared proactive and retroactive inhibition effects. The task were recall of a 6 sec force response of greater magnitude than criterion, a 6 sec force response of lesser magnitude than criterion, counting backward for a 6 sec period and passively sitting for a 6 sec period. These tasks were used either before or after the criterion response. Two inter-response intervals were used in this study, viz. 4 and 14 sec. Effect of the tasks was significant for retroactive inhibition but not for proactive inhibition. Craft and Hinrich (1971) studied proactive and retroactive inhibition using a postcuing method in which subject was informed about the movement to be recalled after both were executed. In their precuing method, the subject was informed about the movement to be recalled before either was executed. Both precuing and postcuing conditions produced interference effect and supported memory trace interaction hypothesis.

Roy and Devenport (1972) varied the number of interpolated learning trials (0, 2 or 4) and studied its

3:41

3.42 effect on the retention of positioning responses. Forgetting occurred due to 4 interpolated learning trials and errors increased with length of retention intervals. They supported the view that interference is a major factor in causing forgetting. Trumbo et al (1972) reported assimilation of traces due to the interpolation of movements.

Laabs (1974) studied the effect of an interpolated movement on the retention of lever positioning movements involving either location or distance information. He reported that interpolation caused directional biasing for location reproduction, while the length of movement caused similar directional biasing for distance reproduction. Variable error analysis indicated that interpolated movements which were not to be remembered interfered with distance information but had no effect on recall of location information. It was also shown that long movements were more susceptible to interference from the interpolated movement than short movements.

Diewert (1975) used interpolated activities which required the subject to judge which of the two movements was short either after kinesthetic experience of the two or after seeing the two on a screen. It was found that both kinesthetic and visual judgements interfered with location information but distance information was interfered by kinesthetic judgement only. Therefore, it was concluded that location is coded in a joint visual kinesthetic store, while distance in a kinesthetic store.

3.43 Laabs (1976 b) studied structural/capacity interference in the retention of location and distance informations using a lever positioning response. He found that remembering movement length or end location of an interpolated movement caused equal interference in the reproduction of end locations. Moreover, recall of interpolated location was better than that of interpolated distances. Since no additional interference was noted when interpolated information was location, he argued in favour of capacity interference rather than structural interference.

Effects of pre-stimulus and post-stimulus cues were studied by Laabs (1977) on the reproduction of location and distance over a delay period of 10 sec. He reported that the interaction between reproduction cue and time of cue designation was not significant at the conventional levels but a weak trend showing that the reproduction of location was slightly worse under post-stimulus than pre-stimulus cue designation condition, was found. Distance reproduction was slightly better in post-stimulus than in pre-stimulus cue designation condition. It was concluded that under double cuing condition reproduction of location was not significantly affected by simultaneous attention to location and distance.

Still another research drive in the stream of interference studies is the study of response biasing effect. Pepper and Herman (1970) studied short term

3.44 retention of force of discrete motor acts. They found that performance decreases over unfilled intervals and proprioceptive interpolation interferes with the decaying traces. Recall response shifted in the direction of the magnitude of interpolated force activity. The major thesis of this paper was a dual process theory which accommodates both trace decay and interference explanations.

Stelmach and Walsh (1972) varied the time at interpolated location and produced strong support for response biasing effect. They found that forward biasing condition caused more forgetting than backward biasing condition. Constant error analysis revealed that forward condition shifted errors in the positive condition and backward condition in the negative direction. This study also indicated that directional shift in error increases with time spent at the interpolated locations. These results were supported in a subsequent study also which reported interference when the subjects had to remember an interpolated movement while recalling criterion end location (Stelmach and Walsh, 1973).

Stelmach et al (1976) studied response biasing effect for both preselected and constrained curvilinear movements. They reported response biasing effect in both types of movement.

3.45 Review of Studies on Motor Behaviour of Blind Subjects

A person with one tenth or less of normal vision is considered as legally blind (Scott, 1969). But for academic purposes visual handicap denoted by blindness varies with the degree of sight retained and the age of its onset because both determine the visual imagery. If blindness has been acquired before 5 years of age, it is generally agreed that the person does not have any useful visual imagery and is as good as born blind for study purposes. Lowenfeld (1950) classified blindness as below :

(1) Total blindness, congenital or acquired before 5 years of age;

(2) Total blindness, acquired after 5 years of age;

(3) Partial blindness, congenital;

(4) Partial blindness, acquired.

For the purpose of present studies the term blind refers to the totally and the congenitally blind persons only who do not have useful visual imagery.

Whether the blind subjects could acquire the knowledge about space in the absence of visual imagery has been subject to debate for a long time (already referred in Chapter 1). Answering to the question how blindness affects cognitive activities of blind people, Lowenfeld (1950) indicated three restrictions imposed by blindness: range and variety

3.46 of experience, ability to get about or mobility, and control of environment and self in relation to the environment.

In a recent theoretical review by Jones (1975) concerning perceptual abilities of blind and sighted subjects, two major theoretical viewpoints have been put forward, i.e. 'the visual map' and the 'motor organizational' theory. A visual map theory is based on the findings which show that blind subjects' performance on various cognitive tasks is inferior to sighted subjects. It emphasizes that vision is primary and necessary for spatial and kinesthetic representation. A motor organization explanation, on the other hand, suggests that because there are anatomical connections between sensory and motor cortex, the later may serve as a pathway for various senses. This view point proposes integration of all sensory informations for spatial representation and hence refutes the primary role of vision or any other sense for that matter.

There is no need to review here enormous and rich literature on spatial information processing dealing with sighted and blind people as it has been published from time to time (Axelrod, 1959; Brown and Straton, 1925; Drever, 1955; O'Connor and Hermelin, 1978). Therefore, to serve our purpose only a selective review on motor behaviour of blind and sighted subjects is presented. In an early study Senden (1932) found that the blind subjects, who

3.47 restored sight later in life, were unable to reach correctly to the objects at first sight and tended to overshoot or undershoot their responses. In another study by Gregory (1966), it was reported that a patient who restored sight by cranial grafting recognized the tactually experience objects in the past at first sight but was poor in perception of height or distance.

In one of the most systematically conducted studies by Worchel (1951) the congenitally blind, the later blinds, and the sighted subjects were compared on tactile form discrimination, tactile space relations, and mobility in space. His results indicated that visual imagery was not required for tactual form recognition but verbal recall and drawing reproduction needed it very much. Visual imagery was also found useful for a tactile space relation task. On a mobility task in which the subjects were moved along two sides of a triangle and demanded to reproduce it by walking back to the starting point, it was found that the blindfolded sighted subjects were better than both the blind groups. It was suggested that both the blind groups seem to use time as an alternative or additional cue to visual or kinesthetic informations. This finding on mobility showed that visual imagery is useful for movement acquisition also.

3.48 White et al (1964) reported that prior visual experience of one's own limb movement influences the development of reaching movement of children. Their results led them to suggest that blind subjects would be retarded in their performance.

There are studies which have reported contrary findings. Gomulicki (1961) found that performance of the blind subjects is initially inferior than the sighted subjects on both stylus and life size maze tasks, but they recovered and performed better than the sighted subjects by 15 years of age. Fraiberg (1968) reported that the blind subjects did not differ from the sighted subjects in the development of head lifting, rolling over or sitting up but noted some differences between them in crawling behaviour. It was delayed in the blind children. The reason suggested for this delay is the lack of incentive for locomotion. It was reported by Shagan (1970) that blind subjects show better kinesthetic short term retention than their sighted counterparts. Similarly, Jones (1975) also suggested on the basis of the findings on cutaneous and kinesthetic localization tasks that the blind subjects were better than the sighted subjects on both the tasks.

Hermelin and O'Connor's (1975) study is very much relevant for the present study because it examines the role of visual reference system in immediate reproduction of

3.49 isolated movement informations. They compared blind, blindfolded sighted and the autistic children on location, distance, or location plus distance tasks. Autistic children were used because they are unable to draw cognitive inferences from visual reference data and mainly depend on kinesthesis. They found that blind and blindfolded sighted subjects do not show any difference in immediate reproduction of location information. Similar findings were obtained in reproduction of location plus distance information task. Their autistic children showed more error than both blind and blindfolded sighted children on these tasks. Analysis of absolute errors of this experiment showed that with increase in length of distance the blind subjects became increasingly inferior to those in the sighted group. The autistic children were found poorer than the sighted on both short and long targets. These findings suggest that a visual reference system is useful for coding distance information but location information can be represented kinesthetically.

The abovementioned studies show that blind and sighted subjects differ in their motor responses and that it is possible to derive meaningful psychological implications based on these differences.

3.50 PILOT STUDY

Processing of linear (horizontal/vertical) and curvilinear discrete movements has been investigated in recent researches in the field of motor short term memory (MSTM). Use of a simple linear slide apparatus to study MSTM was first demonstrated and reported by Adams and Dijkstra (1966). Since then it has been accepted as a standard method in several researchers which have followed in this area in about last one and half decade. Manual Lever-D, used to study retention of semicircular curvilinear movement was deviced by Bilodeau et al (1962). The findings based on both types of movement have clearly shown how analogy between verbal and motor retention could be drawn and in what respect retention of motor activity is distinct from the retention of verbal items. However, the research workers in the area of MSTM have not paid sufficient attention to the problems and limitations involved with the study of linear and curvilinear movements.

If we compare the movement patterns on linear slide and Manual Lever-D apparatuses, we find that the two differ. Linear task involves movement in one direction only, whereas the direction of movement in curvilinear task changes at every step. This implies that the spatio-temporal cues involved in these two movements are not identical. In other words, if the speed of movement is held constant, total

3.51 time taken in reaching a point on a linear movement task is lesser than when the same point is reached through a curvilinear path. Moreover, in a curvilinear task there is an upward movement upto 90° level and, thereafter, it has downward movement. Therefore, in this task one has a reference point in upward or downward movement to recall a movement. The linear movement, on the other hand, does not provide this cue. This argument receives support from the finding that recall accuracy is highest around 90° level in a curvilinear type of movement (Stelmach, 1970).

In their study on kinesthetic judgements involved in reproducing angular movement, Marteniuk and Roy (1972) pointed out that the discrepancies in MSTM research results might be due to failure to appreciate that "memory for several motor tasks requires encoding different types of information each with its own unique retention characteristics" (p. 471). Such an argument implies that the information arising out of linear and curvilinear movements would be different in the kinesthetic sensory system responsible for the perception of movement and position of arm with reference to body position.

These arguments clearly show that movements on linear and curvilinear type of apparatuses involve different spatio-temporal cues. Due to this reason, it is important to identify the conditions in which these two types of

3.52 responses differ and, subsequently, to explain how this difference has implications for future research on MSTM. In fact, some of the confusions with respect to findings based on linear and curvilinear movements has already started puzzling the researches in this field, e.g. in recent studies by Nacson (1973) and Diewert and Stelmach (1978) on the role of perceptual organization in motor learning. Some of the findings have been found contradictory because the former used a curvilinear task, while the latter a linear task. Diewert and Stelmach believed that a curvilinear apparatus 'somehow facilitated organization' but could not exactly say how it did. Their experiment required the subjects to move to different targets in a sequential (10-20-30-40-50 cm) long/short or random order (50-10-40-20-30 cm).

It is proposed that the answer to the problems of the aforesaid nature lies in the central processing capacity (CPC), a central issue in the researches on MSTM. It is generally agreed that human beings receive information from a vide variety of sense modalities, e.g., vision, audition, proprioception, etc., and that all the available information is transformed into some internal code. When a blindfolded individual is asked to make a movement his internal code is mainly based on proprioceptive information coming from muscle or joints of the body. A record of motor outflows is stored in the brain which could be reproduced later when

3.53 required. However, sighted individuals are so much in habit of relying on visual cues that they tend to store cues in the form of visual imagery. This tendency causes difficulty in judging the role of kinesthetic or proprioceptive cues involved in the task. In fact, their reliance on visual factors is so great that neither amount of practice nor proprioceptive feedback have been found to influence the detection or correction of errors in performance in the absence of visual cues (Adams et al, 1972 a). Since most of the studies conducted so far have employed only blindfolded normals, the difference between linear and curvilinear movements has been ignored owing to a possible assumption that these two types of tasks are too simple to make any characteristic impact on MSTM studies.

In Hermelin and O'Connor's (1975) study which was reviewed earlier, the ability of blindfolded normal and congenitally blind children to reproduce movements on a vertical linear slide was investigated. They found that blindfolded sighted subjects and blind subjects performed very similarly on simple reproduction and location task, i.e. reproduction of end location of standard movement; but they differed significantly on the distance reproduction task, i.e. reproduction of the total extent of standard movement. Therefore, they concluded that the kinesthetic data are adequate for coding the location of movement but not the distance of movement. One of the most interesting aspect

3.54 of their finding was that blind subjects were found reluctant to extend their arms above head height and were not responsive to higher target heights. Moreover, blind subjects seem to have nonlinear metric for vertical space, as judged from their bodily movements. This conclusion was based on the analysis of error scores at three lowest heights which did not show only difference between blind and sighted people but also how they diverged progressively after that. A comparison between the performance of blind and autistic subjects was also made in this study. Autistic children often fail to process visual information even when it is available. It was concluded that when tasks could be solved by the use of directly available kinesthetic data, blind as well as autistic subjects performed adequately, but not when inferential judgements in terms of perceptual reference system was required.

The present section describes three pilot experiments which were conducted to generate some useful hypotheses about the role of visual reference system in retention of movement related informations. These experiments deal with direct comparison of blindfolded sighted and congenitally blind subjects for their performance on movement retention tasks. Types of movement studied in these experiments were mainly horizontal, vertical and curvilinear movements. Experiment 3.1 deals with simple reproduction of movements by sighted and blind subjects over

3.55 brief periods of delays. In Experiment 3.2 attempts were made to examine immediate reproduction of simple movement (location plus distance), location, and distance tasks; and to explore the role of visual reference in processing of these informations. Experiment 3.3 is an extention of Experiment 3.2 with the exception that simple reproduction task (location plus distance) was discarded since it revealed similar properties to that of location task.

EXPERIMENT 3.1

Method and Procedure

Sample. In this experiment 18 congenitally blind and 18 sighted adults voluntered as subjects. Blind subjects had been sightless since birth and they were staying or working in a local workshop for the blind. Both blind and sighted subjects were matched on educational attainments and intelligence. Only right-handed subjects were included in the sample.

Apparatus and Materials. A linear slide as reported by Adams and Dijkstra (1966) was used for the horizontal task. It was 55 cm in length mounted with a starting lever and a stop peg (Fig. 3.1.1). Sliding the lever gave nearly frictionless movement and it could be stopped by the experimenter at any desired target by fixing the stop peg.

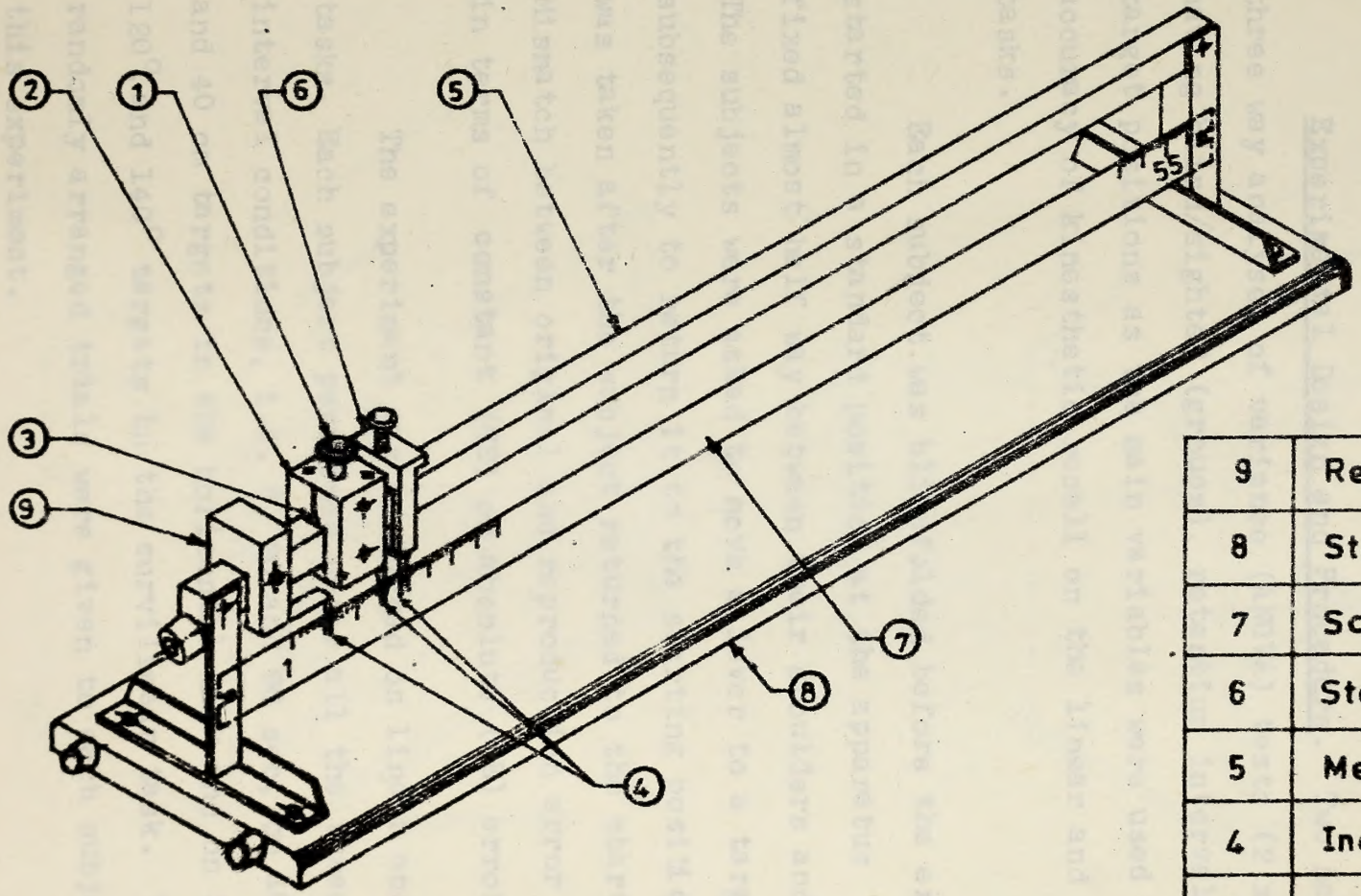


FIG.3.1.1 LINEAR SLIDE

9	Removable stop peg
8	Stand
7	Scale
6	Stop peg
5	Metal bar
4	Indicators
3	Ball bearing
2	Slide
1	Handle

1	Handle wheel
2	Slide
3	Ball bearing
4	Indicators
5	Metal rod
6	Stop peg
7	Stops
8	Stand
9	Removable stop peg

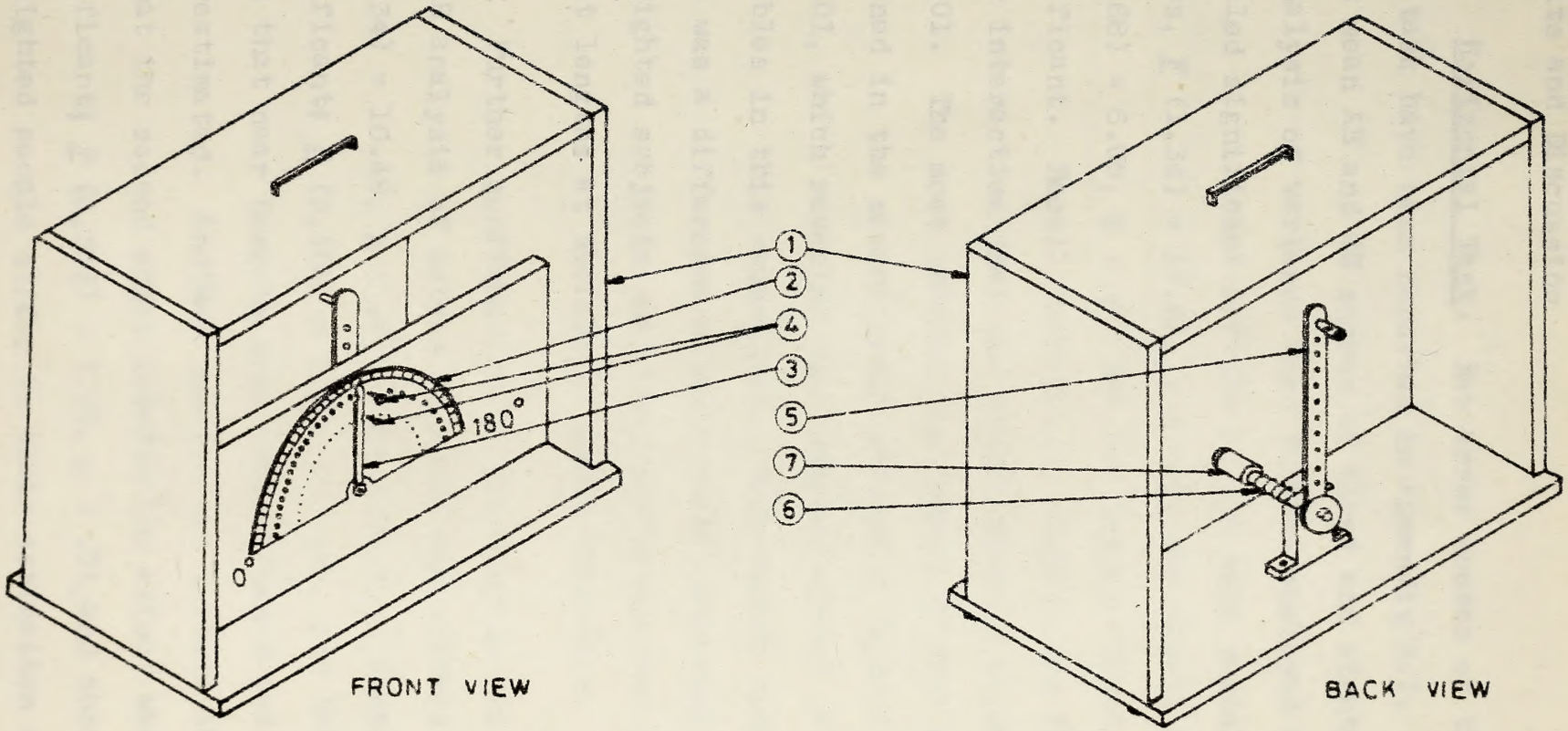
FIG 2.11 LINEAR SLIDE

3.56 For studying curvilinear movement, a D-shape apparatus as used by Bilodeau et al (1962) was used (Fig. 3.1.2). The radius of the semicircle was 22.5 cm and each angle was separated by a gap of 4 mm. A stop peg was used to stop movement at any target as the subject moved along the arc.

Experimental Design and Procedure. Two separate three way analyses of variance (ANOVA) tests (2 x 3 x 4) having blind/sighted (groups), retention intervals, and target positions as the main variables were used to examine accuracy of kinesthetic recall on the linear and curvilinear tasks.

Each subject was blindfolded before the experiment started in a standard position at the apparatus which was fixed almost half way between their shoulders and hips. The subjects were asked to move a lever to a target and subsequently to return it to the starting position. Recall was taken after the subject returned to the starting point. Mismatch between original and reproduction error was analysed in terms of constant (CE) or absolute (AE) errors.

The experiment was conducted on linear and curvilinear tasks. Each subject performed under all the three retention interval conditions, i.e. 5, 20 and 90 sec, on 10, 20, 30, and 40 cm targets in the horizontal task and on 30°, 50°, 120°, and 140° targets in the curvilinear task. Twelve randomly arranged trials were given to each subject in this experiment.



(1) WOODEN BOX (2) PROTRACTOR. (3) INDICATOR. (4) STOP PEGS. (5) LEVER.
(6) SPRING. (7) SHAFT CONNECTING THE LEVER WITH INDICATOR.

FIG. 3·1·2. MANUAL LEVER–D.

BACK VIEW
FRONT VIEW

3.57 Results and Discussion

Horizontal Task. Raw error scores of the subjects on this task have been reported in Appendix 3.I. Table 3.1.1 shows mean AE and CE scores of blind and sighted groups. An analysis of variance test (ANOVA) employed for AE scores revealed significant effects of two main variables, i.e. groups, F (1,34) = 17.96, $p < .01$, and recall intervals, F (2,68) = 6.09, $p < .01$ but the target effect was not significant. Recall intervals x targets was the only first order interaction that was significant: F (6,204) = 6.06, $p < .01$. The most interesting result of this analysis was obtained in the second order effect: F (6,204) = 10.21, $p < .01$, which revealed the conjoint effect of the three variables in this experiment. This result indicates that there was a difference between recall accuracy of blind and sighted subjects when they estimated near and far target lengths at different recall intervals.

Further confirmation of the results was obtained in the AE analysis of scores of blind and sighted subjects: F (1,34) = 16.48, $p < .01$. The effect of targets was also significant; F (3,102) = 7.80, $p < .01$, and this finding shows that near targets were overestimated and far targets underestimated. Another interesting feature of this analysis is that the second order interaction effect was again found significant; F (6,204) = 5.26, $p < .01$, and shows that blind and sighted people differ in their estimation of short and long targets with delay in recall.

3.58

TABLE 3.1.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE AND CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL MOVEMENT

ERROR	TARGETS (cm)	SIGHTED			BLIND		
		Retention Interval in sec			Retention Interval in sec		
		5	20	90	5	20	90
AE	10	2.63 (1.74)	2.82 (1.62)	2.93 (2.67)	5.81 (6.68)	6.48 (6.15)	10.70 (10.01)
	20	2.08 (1.61)	2.22 (2.02)	3.78 (3.26)	3.31 (3.90)	7.41 (7.29)	7.06 (4.79)
	30	2.44 (1.75)	3.99 (3.35)	4.02 (4.28)	4.67 (3.78)	3.91 (2.69)	4.25 (3.96)
	40	2.05 (1.30)	2.34 (2.25)	3.97 (2.82)	3.77 (2.56)	3.97 (4.06)	6.98 (6.03)
CE	10	1.16 (3.02)	1.78 (2.78)	2.28 (3.28)	5.81 (6.68)	6.26 (6.39)	10.20 (10.55)
	20	0.31 (2.67)	-1.28 (2.75)	0.24 (5.07)	3.02 (4.14)	6.19 (8.41)	4.84 (7.14)
	30	-0.86 (2.93)	-0.46 (5.28)	1.10 (5.85)	2.93 (5.32)	1.39 (4.62)	2.19 (5.45)
	40	-1.10 (2.20)	-1.11 (3.10)	-2.70 (4.12)	1.71 (4.30)	-1.62 (5.48)	1.02 (9.32)

3.59 Curvilinear Task. Raw scores of subjects of this task have been shown in Appendix 3.II. Average AE and CE of blind and sighted groups for this task are reported in Table 3.1.2. An ANOVA test yielded significant effect of groups and recall intervals ($p < .01$). However, in the analysis of AE of the horizontal task target length did not affect the results significantly.

Besides the significant effect of recall intervals x targets ($p < .01$), groups x targetseffect was also found significant ($p < .05$). Unlike the findings of the horizontal task, this later finding on the curvilinear task indicates that the extent of AE decreases among blind subjects with increase in the length of targets, but this was not so in the case of sighted subjects. However, the significant second order interaction ($p < .01$).available in this analysis bears resemblance to the results obtained in the horizontal task.

An ANOVA test on CE data yielded significant differences for groups, F (1,34) = 12.42, $p < .01$; targets, F (3,102) = 7.71, $p < .01$; and recall intervals, F (2,68) = 4.33, $p < .05$. First order interaction effect found significant in this analysis are: groups x retention intervals, F (2,68) = 4.69, $p < .05$, and targets x retention intervals, F (6,204) = 2.15, $p < .05$. Second order interaction failed to reach the level of significance in this analysis.

3.60

TABLE 3.1.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE AND CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR MOVEMENTS

ERRORS	TARGETS (Deg.)	SIGHTED			BLIND		
		Retention Interval in sec			Retention Interval in sec		
		5	20	90	5	20	90
AE	30	4.66 (3.18)	6.00 (3.02)	8.61 (7.06)	16.66 (27.40)	20.22 (25.81)	48.94 (52.34)
	50	4.55 (3.41)	4.33 (3.78)	15.66 (16.21)	13.38 (14.68)	19.33 (17.72)	35.00 (35.93)
	120	8.38 (8.28)	8.11 (7.51)	15.66 (16.56)	12.88 (9.57)	14.16 (13.32)	17.22 (12.87)
	140	6.66 (5.45)	6.16 (5.47)	14.44 (13.18)	8.33 (6.48)	8.83 (6.11)	19.33 (19.79)
CE	30	0.77 (5.70)	5.11 (4.43)	7.83 (7.99)	16.33 (21.61)	19.88 (26.08)	48.94 (52.34)
	50	2.88 (4.94)	0.00 (5.85)	11.66 (19.46)	9.44 (17.34)	15.11 (21.63)	24.55 (27.36)
	120	0.27 (11.95)	1.33 (11.14)	-10.77 (20.27)	0.22 (16.35)	5.83 (18.81)	7.00 (20.68)
	140	3.11 (8.15)	0.50 (8.36)	-2.88 (19.64)	5.77 (8.96)	-2.27 (10.70)	5.88 (27.40)

3.61 A very interesting common result in both horizontal and curvilinear tasks in AE analysis is that blind and sighted subjects differed in interaction with targets and recall intervals. The differences between these two groups is most conspicuous when their performance is compared at the 90 sec delay in recall at the nearest target. This suggests that sighted subjects preprogram their movements for the short targets by deriving support from their visual reference system. On the other hand, in the absence of any visual reference, blind subjects depend on their memory for movement alone, and this is subsceptible to decay at longer recall intervals. Therefore, it is not surprising that the differences between the blind and sighted groups were highest at the 90 sec interval.

The question that remains unanswered is: Why do blind and sighted groups fail to differ with the same magnitude at long targets as compared to their difference at short targets? In fact, the available data indicate that blind subjects even gave better performance than sighted subjects on long targets. One explanation for this result is that with the increase in length of targets the movement of subjects in both groups were guided by feedback and this probably undermined the relative advantage of visual reference system available to the sighted group.

3.62

EXPERIMENT 3.2

Method and Procedure

Sample. Ten congenially blind and 10 blindfolded sighted subjects participated in each task - horizontal, vertical and curvilinear. In all, 60 subjects participated in this experiment. Blind and sighted subjects were matched on their age, educational attainments and intelligence. Only right handed subjects were included in the sample.

Apparatus. Linear slide and Manual Lever-D, which were used in Experiment 3.1, were employed in this experiment also. To study vertical movement the same Linear slide that was used for a horizontal task was employed in vertical fashion.

Experimental Design and Procedure. A 2 x 3 x 5 within subjects design, consisting of blind and sighted (groups), location/distance/simple reproduction (informations) and target lengths as main variables, was employed to examine the accuracy of kinesthetic recall. Only group was a between group variable.

Each subject was blindfolded before the experiment started. Both blind and sighted subjects were placed in a standard position of the apparatus which was fixed almost half-way between their shoulders and hips.

3.63 The tasks of the experiment were identical to those reported by Hermelin and O'Connor (1975). Each subject in this experiment was tested on simple reproduction (location plus distance), location, and distance tasks. In the simple reproduction task, the subject was required to move the slide/lever using right hand from the starting point to a target point fixed by the experimenter and then to return to the starting point. At the return, the subject was asked to move the lever/slide to the target point and indicate it by his signal 'there'. In the location task, the starting point for recall was half-way the distance between the starting and target points of the standard trial and the target point to be recalled was the same as on the standard trial. The distance task required movement of the same extent as on the standard trial but the starting point for reproduction was halfway between the end point and the starting point of the criterion movement.

This experiment was carried out separately on vertical, horizontal, and curvilinear movements. The target lengths for horizontal and vertical tasks were 10, 15, 20, 25, and 30 cm, and for curvilinear task 30°, 50°, 70°, 90° and 110°. In all, each subject received 15 trials (3 information conditions x 5 targets) on a task. The presentation order of these trials were randomized.

3.64 Results and Discussion

Horizontal Task. Raw error scores of the subjects on this task are reported in Appendix 3.III.

Means and S.D. for AE scores of the blind and sighted groups under separate experimental treatments are given in Table 3.2.1. All the main variables in this study contributed significantly in a 3 way ANOVA applied for this data: groups, F (1,18) = 10.90, $p < .01$; informations, F (2,36) = 16.22, $p < .01$; and targets, F (4.72) = 2.59, $p < .05$. Interaction effects failed to reach conventional levels of significance. Trend analysis of data showed strong linearity effect for both targets ($p < .01$) and information ($p < .01$).

Means and S.D. for CE scores of groups under separate experimental conditions are presented in Table 3.2.2. In both groups there is a consistent tendency of change in errors from high to low positive direction as the target length increased. Like in the analysis of AE, all the main variables of this analysis had significant effect: groups, F (1,18) = 10.46, $p < .01$; informations, F (2,36) = 4.26, $p < .05$; and targets, F (4,72) = 8.88, $p < .01$. The only first order interaction found significant was information x targets, F (8,144) = 14.11, $p < .01$. Significant linearity effects for targets ($p < .05$) and informations ($p < .01$) were recorded.

3.65

TABLE 3.2.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Targets (in cm)				
		10	15	20	25	30
Sighted	S	1.23 (1.16)	0.93 (0.59)	1.78 (1.43)	2.11 (1.25)	1.89 (0.94)
	L	0.77 (0.66)	1.01 (0.53)	1.05 (0.58)	1.01 (0.80)	1.34 (1.06)
	D	1.80 (1.38)	2.16 (1.25)	2.87 (1.08)	4.33 (1.64)	6.80 (2.31)
Blind	S	1.87 (1.79)	2.12 (1.19)	2.24 (1.91)	2.50 (2.60)	2.46 (2.72)
	L	2.36 (1.74)	3.17 (1.30)	2.42 (1.54)	2.28 (1.78)	3.23 (1.57)
	D	5.13 (4.50)	4.80 (3.35)	3.70 (1.82)	2.40 (2.23)	4.89 (2.76)

3.65

TABLE 3.2.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AS SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Targets (in cm)				
		10	15	20	25	30
Sighted	S	1.25 (1.16)	0.93 (0.89)	1.78 (1.45)	2.11 (1.95)	1.89 (0.94)
	L	0.77 (0.66)	1.01 (0.85)	1.05 (0.82)	1.01 (0.80)	1.34 (1.06)
	D	1.80 (1.38)	2.16 (1.85)	2.87 (1.08)	4.33 (1.84)	3.80 (2.31)
Blind	S	1.87 (1.79)	2.12 (1.19)	2.24 (1.91)	2.50 (2.60)	2.46 (2.79)
	L	2.56 (1.74)	3.17 (1.30)	2.42 (1.84)	2.28 (1.78)	3.23 (1.87)
	D	5.13 (4.50)	4.80 (3.35)	3.70 (1.82)	2.40 (2.23)	4.80 (2.76)

3.66

TABLE 3.2.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORE OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Targets (in cm)				
		10	15	20	25	30
Sighted	S	0.91 (1.45)	-0.17 (1.13)	-1.36 (1.87)	-2.11 (1.25)	-1.71 (1.27)
	L	0.77 (0.66)	0.65 (0.97)	0.65 (1.04)	-0.37 (1.28)	-0.06 (1.77)
	D	0.84 (2.17)	0.32 (2.57)	-1.63 (2.72)	-4.33 (1.64)	-6.80 (2.31)
Blind	S	1.61 (2.05)	1.32 (2.12)	1.30 (2.71)	0.80 (3.61)	-0.21 (3.11)
	L	2.30 (1.83)	2.97 (1.75)	1.72 (2.36)	1.94 (2.18)	1.53 (3.38)
	D	4.83 (4.86)	3.90 (4.46)	-0.87 (4.22)	-1.50 (2.98)	-3.59 (4.46)

3.67 Vertical Task. Raw error scores of subjects obtained on a vertical task are presented in Appendix 3.IV. A cursory view of mean AE and S.D. scores presented in Table 3.2.3 reveals a striking similarity between the results of this experiment and those reported by Hermelin and O'Connor (1975). Absolute error (AE) on distance information were highest and location showed almost identical pattern of changes in recall error. Target positions showed significant effect, F (4,72) = 6.56, $p < .01$, in this experiment and so did information, F (2,36) = 10.24, $p < .01$. However, the results differed with respect to the differences between the two groups and their interaction with informations, these being insignificant in this analysis. Significant linearity effect for targets ($p < .01$) and recall intervals ($p < .01$) was recorded.

Mean and S.D. scores for CE data are reported in Table 3.2.4. As in AE analysis, analysis of CE also gave insignificant differences between the blind and sighted groups. The effects of information, F (2,36) = 6.94, $p < .01$, and targets, F (4,72) = 7.51, $p < .01$, were significant much like the results obtained in the absolute error analysis. CE differences were also significant for information x targets, F (8,144) = 4.93, $p < .01$, and this finding supported the results obtained in AE analysis. It was found that CE on distance task shifted from positive to negative direction as the target distance increased. Both groups undershot long

3.68

TABLE 3.2.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL SIMPLE(S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Information	Targets (in cm)				
		10	15	20	25	30
Sighted	S	0.45 (0.29)	0.94 (0.37)	1.48 (1.07)	2.22 (1.33)	3.29 (2.31)
	L	0.94 (0.73)	0.98 (0.62)	1.30 (0.78)	1.74 (0.72)	2.07 (1.17)
	D	2.10 (1.53)	2.55 (2.09)	2.72 (1.06)	4.49 (1.50)	5.47 (2.80)
Blind	S	1.94 (2.09)	1.48 (1.13)	2.09 (1.50)	1.67 (1.51)	1.70 (1.37)
	L	2.29 (1.36)	2.21 (1.59)	2.26 (2.76)	2.13 (1.90)	2.95 (2.87)
	D	3.32 (2.71)	3.22 (1.84)	2.12 (1.31)	4.18 (2.71)	6.31 (2.74)

3.69

TABLE 3.2.4

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Information	Targets (in cm)				
		10	15	20	25	30
Sighted	S	-0.11 (0.54)	0.32 (1.00)	-0.46 (1.83)	1.52 (2.17)	-1.73 (3.75)
	L	0.82 (0.87)	0.98 (0.62)	1.10 (1.07)	-0.98 (1.68)	-1.51 (1.89)
	D	1.50 (2.18)	-0.31 (3.39)	0.38 (3.03)	-3.29 (3.55)	-3.87 (4.95)
Blind	S	1.16 (2.60)	0.78 (1.74)	0.79 (2.53)	0.77 (2.17)	1.60 (1.50)
	L	1.97 (1.83)	1.91 (1.98)	2.12 (2.88)	1.23 (2.64)	1.95 (3.70)
	D	2.44 (3.60)	0.98 (3.72)	-0.82 (2.44)	-4.18 (2.71)	-4.71 (5.21)

3.70 targets but overshot the short ones on distance task. However, location and simple reproduction caused different trends in both groups; while the sighted group undershot long targets, the blind subjects overshot these targets.

The above reported analysis of results obtained on the two linear tasks - vertical and horizontal - indicates that the blind and sighted groups differ on horizontal task but not on vertical task. This finding contradicts Hermelin and O'Connor's (1975) conclusion that the blinds differ from the sighted on longer vertical task owing to their reluctance to move their hand beyond head level. If their interpretation is accepted then it would be expected at the same time that blinds would undershoot longer targets with greater magnitude, than those in the sighted group on distance information because in this condition the hand had to be raised beyond head level to judge the target accurately. However, both the groups did not differ significantly in this condition and, therefore, the present results fail to provide support to their interpretation.

Curvilinear Task. Raw scores of subjects obtained on this task are reported in Appendix 3.V.

Means and S.D. for AE data are reported in Table 3.2.5. A significant effect of two main variables was recorded in the ANOVA test: groups, F (1,18) = 7.28, $p < .01$; and informations, F (2,36) = 10.19, $p < .01$. Linearity effect

3.71

TABLE 3.2.5

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Information	Targets (in degrees)				
		30	50	70	90	100
Sighted	S	2.90 (3.25)	5.90 (3.76)	7.00 (4.88)	3.70 (2.67)	5.00 (3.50)
	L	4.60 (3.17)	4.00 (2.49)	5.00 (3.28)	3.80 (3.19)	3.00 (3.86)
	D	6.80 (6.60)	9.00 (3.74)	8.50 (6.08)	14.50 (8.89)	14.20 (10.76)
Blind	S	4.70 (3.86)	3.20 (3.79)	11.80 (6.56)	4.60 (3.03)	7.10 (3.14)
	L	4.30 (3.43)	6.50 (5.68)	5.80 (4.05)	4.50 (5.42)	5.60 (4.35)
	D	12.70 (17.87)	12.80 (12.81)	14.00 (6.88)	13.90 (8.69)	21.60 (10.46)

TABLE 3.2.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Information	Targets (in degrees)				
		30	50	70	90	100
Sighted	S	2.00 (3.25)	3.00 (3.76)	7.00 (4.98)	3.70 (2.67)	5.00 (3.60)
	L	4.60 (3.17)	4.00 (2.49)	8.00 (3.23)	7.80 (5.19)	5.00 (3.86)
	D	6.80 (6.60)	9.00 (3.74)	8.80 (6.06)	14.80 (8.80)	14.90 (10.76)
Blind	S	4.70 (3.86)	3.80 (3.79)	11.80 (6.38)	4.80 (3.05)	7.10 (3.14)
	L	4.30 (3.43)	6.80 (5.68)	5.80 (4.05)	4.80 (3.12)	5.80 (1.35)
	D	12.70 (17.87)	12.80 (12.81)	14.00 (6.88)	13.90 (8.80)	21.80 (10.46)

3.72 for targets ($p < .01$) and informations ($p < .01$) was quite strong.

Means and S.D. for CE data are reported in Table 3.2.6. ANOVA results show that the blind and sighted groups did not differ significantly but the remaining two main variables were significant: information, F (2,36) = 3.87, $p < .05$, and targets, F (4,72) = 7.99, $p < .01$.

One of the most characteristic feature of the data of this experiment is that AE of the blind and sighted subjects on 90° target point did not differ at all on location and simple reproduction tasks and this finding clearly indicates that with the availability of spatial cues both blind and sighted people perform equally well. However, in the absence of this spatial cue their performance diverged at 70° and 100° and no such resemblence in data were recorded. Analysis of CE on this 90° vertical point shows that sighted subjects did not differ on location and simple reproduction but blind subjects did. This later finding indicates that blind people are not sensitive to 90° vertical point but to the curvature which follows after it, otherwise their location and simple reproduction responses would not have been quite identical like those of the sighted people.

3.73

TABLE 3.2.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR SIMPLE (S), LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Information	Targets (in degrees)				
		30	50	70	90	110
Sighted	S	-0.10 (4.46)	-2.10 (6.68)	-1.00 (8.78)	0.70 (4.67)	-2-20 (5.88)
	L	4.60 (3.17)	4.00 (2.49)	2.60 (5.54)	-1.00 (5.01)	2.60 (4.17)
	D	6.80 (6.60)	4.80 (8.85)	-5.30 (9.27)	-12.30 (12.02)	-14.20 (10.76)
Blind	S	-2.70 (5.60)	-1.00 (4.97)	-7.20 (11.84)	-2.60 (5.02)	-1.90 (7.87)
	L	3.10 (4.65)	5.70 (6.57)	2.20 (6.96)	2.70 (6.62)	2.00 (7.02)
	D	11.30 (18.89)	5.80 (17.57)	3.80 (15.78)	-13.30 (9.67)	-13.60 (20.55)

3.74

EXPERIMENT 3.3

Method and Procedure

Sample. Twenty subjects, 10 congenitally blind and 10 sighted, participated in each experiment - horizontal, vertical and curvilinear. The subjects in the two groups were matched with respect to age, sex, intelligence and academic record.

Apparatus. These were the same as described in Experiment 3.1.

Experimental Design and Procedure. A 2 x 2 x 3 x 5 analysis of variance design (within subjects) having groups (blind and sighted), informations (location and distance), retention intervals (5, 20 and 90 sec), and target positions (for horizontal and vertical tasks - 10, 15, 20, 25 and 30 cm; for curvilinear task - 30°, 50°, 70°, 90°, and 110°) as main variables, was employed. Only groups and informations were between group variables, whereas retention intervals and targets were within subject variables. Therefore, each subject received 15 trials randomly arranged with respect to target position and retention intervals. Procedure adopted for isolation of location and distance informations were the same as described in Experiment 3.2.

3.75 Results and Discussion

Horizontal Task. Raw error scores of subjects on horizontal task are reported in Appendix 3.VI.

Means and S.D. for AE data of groups under each separate experimental condition are reported in Table 3.3.1. Analysis of AE showed significant effect of groups, F (1,16) = 17.48, $p < .01$; informations, F (1,16) = 38.86, $p < .01$; and recall intervals, F (2,32) = 10.03, $p < .01$. Among first order interactions only groups x targets was significant, F (4,64) = 4.94, $p < .01$. Separate analysis of location and distance tasks based on simple main effects yielded some useful information. In the location task, the blind and sighted subjects were found significantly different at short targets only. Analysis of the distance task revealed an even more interesting result for these two groups. Although the performance of the blind subjects was almost equally poor as those in the sighted group on short targets of location task, their performance became superior, particularly with delay in recall, to those of the sighted subjects on long targets.

For CE data, means and S.D. of the two groups are presented in Table 3.3.2. Results of ANOVA show a significant effect of targets, F (4,64) = 12.67, $p < .01$, which was not available in AE analysis. Effects of groups, informations, and groups x targets were also found significant at the

3.76

TABLE 3.3.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (in sec)	Targets (in cm)				
			10	15	20	25	30
Sighted	L	5	0.30 (0.28)	0.78 (0.70)	1.44 (1.38)	1.54 (1.38)	2.20 (1.04)
		20	0.52 (0.41)	1.14 (0.90)	2.16 (2.03)	2.30 (1.44)	2.44 (1.62)
		90	1.12 (1.01)	1.40 (1.39)	1.54 (0.66)	2.74 (2.25)	2.26 (1.15)
	D	5	1.86 (0.53)	1.96 (0.99)	1.68 (0.65)	3.12 (0.97)	3.96 (1.36)
		20	1.72 (1.27)	1.82 (1.08)	2.82 (0.43)	5.12 (3.42)	5.64 (3.33)
		90	3.48 (2.15)	2.86 (1.27)	3.50 (1.24)	6.12 (1.66)	6.82 (4.68)
Blind	L	5	3.50 (2.67)	1.76 (1.55)	3.44 (2.86)	1.60 (1.24)	2.70 (1.85)
		20	1.32 (1.33)	2.86 (1.45)	2.84 (2.49)	3.10 (1.19)	2.04 (0.88)
		90	2.26 (1.33)	6.20 (4.37)	3.24 (1.48)	2.34 (2.71)	5.20 (2.80)
	D	5	5.00 (4.76)	4.00 (3.02)	2.20 (2.25)	4.60 (2.27)	3.10 (1.39)
		20	4.26 (2.98)	2.80 (3.87)	4.00 (3.22)	3.14 (2.74)	4.74 (3.23)
		90	6.20 (4.31)	6.30 (2.91)	6.34 (3.07)	4.90 (2.25)	3.38 (3.36)

TABLE 3.3.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF RECTILINEAL LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Inform-ations	Retention Intervals (in sec)	Target (in cm) 10	15	20	25	30
Sighted	L	5	0.30 (0.26)	0.72 (0.70)	1.44 (1.38)	1.84 (1.38)	2.20 (1.04)
		20	0.52 (0.41)	1.14 (0.60)	2.16 (2.03)	2.30 (1.41)	2.44 (1.58)
		30	1.12 (1.01)	1.40 (1.20)	1.84 (0.85)	2.74 (2.38)	3.08 (1.15)
	D	5	1.86 (0.83)	1.86 (0.98)	1.92 (0.65)	3.12 (0.97)	3.96 (1.38)
		20	1.72 (1.27)	1.92 (1.02)	2.88 (0.42)	5.12 (2.42)	5.64 (3.32)
		30	3.48 (2.15)	2.86 (1.27)	3.00 (1.24)	6.12 (1.86)	6.86 (4.62)
Blind	L	5	3.00 (2.67)	1.98 (1.55)	3.44 (2.86)	1.00 (1.74)	2.70 (1.68)
		20	1.32 (1.33)	2.86 (1.48)	2.86 (2.46)	2.84 (1.16)	2.04 (0.88)
		30	2.56 (1.33)	6.00 (4.77)	3.04 (1.48)	2.34 (2.71)	2.84 (2.00)
	D	5	5.04 (4.76)	4.00 (3.08)	2.20 (2.08)	4.00 (2.09)	3.10 (1.38)
		20	4.36 (2.98)	2.80 (3.87)	2.00 (4.42)	3.14 (2.74)	4.96 (3.88)
		30	6.20 (4.31)	6.32 (3.91)	3.24 (3.09)	4.30 (2.82)	3.36 (3.36)

3.77

TABLE 3.3.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (in sec)	Targets (in cm) 10	15	20	25	30
Sighted	L	5	0.30 (0.38)	-0.30 (1.07)	-0.48 (2.05)	-1.14 (1.80)	-0.80 (2.52)
		20	-0.52 (0.41)	-0.62 (1.40)	0.36 (3.13)	-0.50 (2.89)	-1.80 (2.45)
		90	0.48 (1.57)	1.00 (1.77)	0.54 (1.74)	-1.62 (3.34)	-0.82 (2.62)
	D	5	0.26 (2.13)	0.16 (2.40)	-0.56 (1.88)	-1.92 (2.92)	-3.96 (1.36)
		20	-0.68 (2.18)	0.66 (2.18)	-0.70 (3.08)	-5.12 (3.42)	-5.64 (3.33)
		90	-2.04 (3.82)	2.86 (1.27)	-3.50 (1.24)	-6.12 (1.66)	-6.82 (4.68)
Blind	L	5	3.50 (2.67)	1.16 (2.15)	3.44 (2.86)	1.60 (1.24)	2.70 (1.85)
		20	1.24 (1.42)	2.46 (2.18)	2.84 (2.49)	2.10 (2.82)	0.56 (2.37)
		90	2.14 (1.56)	6.20 (4.37)	1.52 (3.53)	2.26 (2.80)	2.60 (5.76)
	D	5	5.00 (4.76)	3.20 (4.04)	1.60 (2.82)	2.40 (4.94)	-1.10 (3.52)
		20	3.46 (4.08)	2.60 (4.04)	4.00 (3.22)	1.46 (4.14)	-3.94 (4.37)
		90	6.20 (4.31)	6.30 (2.90)	2.86 (7.03)	2.10 (5.44)	-2.18 (4.43)

3.78 .01 level in this analysis and these are commonly available in both AE and CE analyses. The information x target effect was also significant, F (4,64) = 6.36, $p < .01$. Trend analysis showed significant effect of targets and recall intervals.

The above results support the findings of previous experiments on horizontal task and add that the errors of the blind and sighted subjects are not identically affected on short and long targets. With increase in recall intervals recall accuracy of the blind subjects became extremely inconsistent. On the other hand, the sighted subjects show consistent increase in AE but decrease in CE under both location and distance conditions. The blind subjects show strong tendency to overshoot short targets, and with lapse of time they tend to undershoot, particularly on distance information; while their sighted counterparts start undershooting at relatively short targets.

Vertical Task. Raw error scores of subjects for vertical task are presented in Appendix 3.VII.

Means and S.D. for AE of the two groups are presented in Table 3.3.3. An ANOVA test for this data indicates that all the main variables were significant: Groups, F (2,16) = 8.61, $p < .01$, informations, F (1,16) = 58.67, $p < .01$; retention intervals, F (2,32) = 5.40, $p < .01$, and targets, F (4,64) = 7.44, $p < .01$. Among the first order interactions

3.79

TABLE 3.3.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (sec)	Targets (in cm)				
			10	15	20	25	30
Sighted	L	5	0.86 (0.66)	0.78 (0.58)	0.74 (0.61)	1.70 (0.80)	1.40 (0.34)
		20	0.30 (0.28)	0.66 (0.83)	1.04 (0.36)	1.66 (0.50)	3.20 (0.46)
		90	0.76 (0.67)	0.90 (0.39)	1.62 0.98)	0.80 (1.08)	2.66 (1.15)
	D	5	1.04 (0.67)	1.12 (0.55)	2.66 (1.13)	3.40 (2.77)	4.98 (2.36)
		20	2.00 (1.48)	2.08 (1.09)	1.56 (1.39)	4.00 (2.14)	6.16 (3.25)
		90	2.14 (1.88)	2.54 (2.29)	5.06 (2.50)	6.74 (2.52)	8.86 (3.49)
Blind	L	5	1.64 (1.25)	0.74 (0.52)	2.48 (2.03)	2.08 (1.45)	3.16 (3.30)
		20	1.84 (1.24)	1.18 (1.63)	0.92 (0.97)	3.84 (3.38)	3.54 (3.32)
		90	3.14 (2.16)	2.34 (2.64)	2.18 (2.18)	2.44 (1.45)	3.66 (2.22)
	D	5	6.72 (4.20)	4.90 (2.43)	3.70 (2.05)	1.80 (1.23)	4.10 (3.51)
		20	3.92 (3.74)	3.30 (3.25)	3.66 (4.23)	4.16 (1.74)	3.44 (2.68)
		90	6.18 (5.41)	3.60 (4.75)	4.28 (4.80)	4.94 (3.24)	4.04 (2.23)

3.80 groups x targets was significant, F (4,64) = 4.77, $p < .01$. A second order groups x informations x targets interaction was also significant, F (4,64) = 4.40, $p < .01$, and it reveals that the two groups do not use location and distance cues similarly at short and long targets.

Means and S.D. for CE of the two groups are presented in Table 3.3.4. Main effects of only groups, F (1,16) = 31.25, $p < .01$, and targets, F (4,64) = 12.17, $p < .01$, were found significant in this analysis. Interesting enough was a groups x informations interaction which was not found significant elsewhere in the previous analyses. The results show that the sighted subjects have a tendency to undershoot both location and distance targets but the blind subjects, on the other hand, overshoot location targets only. In reproduction of distance, blind subjects undershoot less than the sighted subjects.

Curvilinear Task. Raw error scores of subjects are presented in Appendix 3.VIII.

Means and S.D. for AE are reported in Table 3.3.5. All main effects were found significant: groups, F (1,16) = 33.49, $p < .01$; informations, F (1,16) = 93.46, $p < .01$, retention intervals, F (2,32) = 6.04, $p < .01$, and targets, F (4,64) = 10.90, $p < .01$. Only targets x informations effect was found significant among interactions. Computation of simple main effects separately for the distance and

3.81

TABLE 3.3.4

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (sec)	Targets (in cm) 10	15	20	25	30
Sighted	L	5	0.06 (1.16)	-0.62 (0.78)	-0.18 (1.01)	-0.60 (1.41)	-0.32 (1.56)
		20	-0.30 (0.28)	0.22 (1.08)	-0.16 (1.20)	-0.26 (1.90)	-2.20 (2.64)
		90	0.30 (1.01)	-0.34 (1.01)	-0.42 (2.00	0.12 (1.40)	-1.28 (2.49)
	D	5	0.80 (1.00)	0.80 (1.03)	-0.26 (3.17)	-2.60 (3.70)	-2.98 (5.05)
		20	1.60 (2.00)	0.12 (2.56)	-1.36 (1.63)	-2.40 (4.17)	-3.96 (6.20)
		90	-0.26 (3.03)	-0.14 (3.64)	-3.86 (4.43)	-2.74 (7.33)	-7.46 (6.38)
Blind	L	5	1.20 (1.77)	-0.46 (0.83)	-0.12 (3.43)	-0.04 (2.74)	-0.75 (4.46)
		20	1.76 (1.37)	0.50 (2.02)	-0.40 (1.34)	2.16 (4.90)	0.44 (4.81)
		90	3.14 (2.16)	2.34 (2.64)	1.14 (3.01)	-1.20 (2.78)	-0.54 (5.13)
	D	5	6.72 (4.20)	3.70 (1.96)	2.50 (3.67)	0.92 (2.12)	-1.70 (4.45)
		20	3.92 (3.74)	1.90 (4.44)	2.26 (5.31)	0.64 (4.91)	-2.90 (4.77)
		90	6.18 (5.41)	2.40 (5.62)	4.28 (4.80)	1.26 (6.24)	-2.04 (4.1o)

3.82

TABLE 3.3.5

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (sec)	Targets (in degrees) 30	50	70	90	110
Sighted	L	5	2.40 (1.14)	4.20 (2.59)	4.00 (2.74)	3.60 (2.70)	5.00 (3.39)
		20	1.60 (1.95)	3.40 (1.82)	3.00 (2.12)	2.00 (2.35)	5.80 (2.59)
		90	5.40 (3.51)	5.80 (1.64)	2.80 (1.92)	5.20 (4.15)	4.60 (2.97)
	D	5	9.60 (5.18)	8.60 (3.51)	10.60 (3.92)	7.60 (6.27)	14.00 (11.11)
		20	10.60 (7.02)	6.80 (5.81)	4.00 (2.44)	10.00 (5.45)	22.6 (4.51)
		90	8.40 (6.88)	13.80 (11.86)	9.40 (10.45)	10.40 (10.14)	17.00 (7.84)
Blind	L	5	6.20 (5.26)	3.80 (1.30)	3.40 (2.94)	4.00 (3.54)	13.20 (7.19)
		20	8.20 (5.45)	5.80 (4.15)	4.40 (2.19)	5.40 (3.05)	11.20 (6.69)
		90	11.40 (6.84)	9.40 (7.33)	10.00 (11.11)	10.60 (6.19)	9.60 (5.59)
	D	5	7.40 (6.11)	11.40 (9.66)	12.00 (7.68)	13.00 (8.86)	23.20 (6.98)
		20	14.60 (7.92)	14.60 (13.05)	14.80 (9.26)	9.40 (5.13)	24.80 (0.84)
		90	18.20 (12.81)	22.80 (20.25)	18.60 (6.91)	11.60 (7.96)	28.40 (11.72)

TABLE 3.3.5

MEAN AND S.D. (GIVEN IN BRACKETS) OF AN SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Inter-mations	Retention Intervals (sec)	Terms (in degrees)			
			30	50	70	90
Sighted	L	5	2.40 (1.14)	3.20 (2.38)	4.00 (3.74)	5.00 (2.70)
		20	1.80 (1.95)	3.40 (2.89)	3.00 (2.12)	5.00 (3.38)
		90	5.40 (3.81)	5.80 (1.81)	5.80 (1.20)	8.80 (4.15)
	D	5	9.80 (6.18)	8.50 (5.31)	10.30 (4.82)	7.00 (6.27)
		20	10.60 (7.02)	6.80 (5.81)	4.00 (2.45)	10.00 (6.31)
		90	8.40 (6.88)	13.80 (11.85)	9.10 (10.45)	10.40 (10.14)
Blind	L	5	6.30 (5.26)	3.80 (1.30)	3.40 (2.84)	4.00 (3.79)
		20	8.20 (6.45)	5.80 (4.15)	4.20 (2.12)	8.40 (5.05)
		90	11.40 (6.84)	9.40 (7.89)	10.00 (11.11)	10.60 (6.15)
	D	5	7.40 (6.11)	11.40 (9.89)	12.00 (8.96)	13.00 (6.58)
		20	14.60 (7.92)	14.00 (13.05)	9.60 (9.36)	5.12 (5.12)
		90	18.80 (12.81)	22.80 (20.25)	12.60 (6.01)	11.60 (7.96)

3.83 location tasks revealed some different results in contrast to linear task analysis. The most interesting finding of location task was that the blind and sighted groups did not differ from each other at short-recall intervals (i.e. 5 and 20 sec), but they did differ at a delayed recall interval (i.e., 90 sec). These results show that on a curvilinear task the blind subjects make effective use of their kinesthetic cues and perform almost equally as well as their sighted counterpart. However, it was only at the 90 sec recall interval, when much of the movement information is lost, that the sighted subjects were found superior. Analysis of AE of the distance task did not reveal any significant difference between the two groups at the 5 sec recall interval, but differed at short targets upon delay in recall.

Means and S.D. for CE of the two groups are reported in Table 3.3.6. In this analysis, only target effect emerged as a main significant variable, $\underline{F}$ (4,64) = 40.39, $p < .01$. Two first order interactions were also found significant: groups x targets, $\underline{F}$ (4,64) = 3.96, $p < .01$, and informations x targets, $\underline{F}$ (4,64) = 13.92, $p < .01$.

General Discussion

The findings reported here show consistently that the blind subjects were poorer than the sighted subjects in their recall accuracy of short targets involving simple reproduction of movements. The results of this study imply that the

3.84

TABLE 3.3.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Informations	Retention Intervals (sec)	Targets (in degrees) 30	50	70	90	110
Sighted	L	5	2.40 (1.14)	3.80 (3.27)	0.80 (5.17)	2.00 (4.30)	-1.40 (6.35)
		20	1.20 (2.28)	-1.40 (3.91)	-2.60 (2.70)	1.60 (2.70)	-0.20 (6.98)
		90	2.20 (6.53)	1.00 (6.60)	-2.80 (1.92)	-4.00 (5.57)	-4.60 (2.97)
	D	5	9.60 (5.18)	4.20 (9.09)	5.80 (10.66)	-6.80 (7.33)	-14.00 (11.11)
		20	9.80 (8.35)	4.80 (7.92)	4.00 (2.74)	-7.60 (9.10)	-14.60 (19.81)
		90	8.40 (6.88)	11.00 (15.08)	-1.40 (14.74)	-2.40 (15.19)	-17.00 (7.84)
Blind	L	5	4.60 (7.02)	0.20 (4.44)	1.00 (4.69)	1.60 (5.41)	-10.00 (12.02)
		20	6.60 (7.70)	-2.60 (7.13)	0.00 (5.39)	-3.40 (5.59)	-11.20 (6.69)
		90	11.40 (6.80)	7.00 (10.15)	8.00 (12.98)	-7.40 (10.50)	-2.00 (11.90)
	D	5	7.00 (6.67)	10.60 (10.74)	-1.40 (15.96)	-9.80 (13.03)	-23.20 (6.98)
		20	14.60 (7.92)	8.20 (18.78)	12.80 (12.44)	-6.20 (9.42)	-24.80 (0.84)
		90	18.20 (12.81)	20.00 (23.66)	0.00 (21.71)	1.20 (15.16)	-28.40 (11.72)

TABLE 3.3.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF CS SCORES OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION (L) AND DISTANCE (D) MOVEMENTS

Groups	Instructions	Retention Intervals (sec)	Targets (in degrees)			
			30	60	90	120
Sighted	L	5	2.40 (1.14)	3.80 (3.27)	0.80 (5.17)	2.00 (4.30)
		20	1.20 (2.28)	-1.40 (3.81)	-2.80 (2.70)	1.60 (2.38)
		60	2.80 (6.83)	1.00 (6.80)	-2.80 (1.92)	-4.00 (5.37)
	D	5	9.80 (5.18)	4.20 (9.09)	5.80 (10.66)	-6.80 (9.33)
		20	9.80 (8.35)	4.80 (7.92)	4.00 (3.94)	-7.60 (9.10)
		60	8.40 (6.88)	11.00 (15.08)	-1.40 (14.74)	-2.40 (15.19)
Blind	L	5	4.60 (7.08)	0.20 (4.14)	1.00 (4.89)	1.60 (5.41)
		20	6.80 (7.70)	-2.60 (7.13)	0.00 (5.39)	-3.40 (6.89)
		60	11.40 (6.80)	7.00 (10.15)	8.00 (12.98)	-7.40 (10.80)
	D	5	7.00 (6.87)	10.60 (10.74)	-1.40 (15.96)	-8.80 (15.05)
		20	14.60 (7.98)	8.20 (18.98)	12.80 (17.44)	-6.20 (9.49)
		60	18.80 (12.81)	20.00 (23.96)	0.00 (21.71)	1.80 (15.15)

3.85 sighted subjects did derive benefit from their visual reference system in producing a response that matched the standard movement more accurately than the blind subjects did. These results also indicate that although movement involves kinesthetic feedback, a visual reference system can integrate with the kinesthetic system to guide a response. On the other hand, the difference between these two groups narrowed, or even reversed, with the increase in length of targets. If long movements operate under feedback control, the superior performance of the blind group is obviously expected because of their greater dependence on kinesthetic information.

The results obtained on the location and distance informations extend these findings. Because the sighted subjects showed less errors than the blind subjects in recalling short targets of horizontal task, the advantage of visual reference system alone can be considered responsible for this difference. On the other hand, the curvilinear movements of both blind and sighted groups were not significantly different on the location task. Although the blind and sighted groups did not differ on curvilinear movements, they differed on linear tasks, i.e. horizontal and vertical, in the Experiment 3.3.

A plausible explanation can be given for these findings. It seems that sighted subjects are unable to derive benefits from their visual reference system while making curvilinear

3.86 movements. In other words, integration of kinesthetic information with information arising from the visual reference system provides an important clue that explains superior performance of the sighted group on short targets of horizontal task irrespective of location and distance cues. Conversely, when kinesthetic cues alone are relied upon as is the case in distance task, the sighted subjects perform poorer than the blind subjects on long targets of horizontal task.

This interpretation is strongly supported by the absence of a difference between the blind and sighted groups in their use of the distance cue in making curvilinear movements. Due to a mismatch between the standard movement and the test movement both the groups perform in the same way, particularly at the long targets. However, this explanation does not account for the difference between them with the location cue, for this task involves partial use of the original format of movements and no mismatch exists between the standard and test movements. Another reason may be that the location task with a curvilinear movement facilities organization of movements (Diewert and Stelmach, 1975). It is well established that some points in the curvilinear task (e.g. 90° point) cause spatial coding (Stelmach, 1970). The upward of downward movement on an angular task itself may become a strong cue. However, a word of caution is added here regarding this interpretation.

3.87 Because linear and curvilinear movements cannot be compared simultaneously owing to difficulty in defining the exact length of movements on these two types of tasks in an identical way, this conclusion remains tentative.

There is also evidence that the blind subjects consistently estimated both near and far targets longer than their sighted counterparts. Previous researches reported that short targets are overestimated and long targets underestimated. By and large, this trend was observed in both groups of this study, but the longer responses of the blind group compared with the sighted group in almost all the conditions show the behavioural characteristic of this group. It seems that in the absence of visual reference system their responses are not firmly controlled by a motor program, but tend to be guided by feedback control. This interpretation receives support from a recent study by Millar (1977). She reported that blind subjects rely on movement sequences, whereas sighted subjects can use some form of spatial layout.

Taking a clue from the aforementioned results, it is worthwhile to examine some of the implications of the motor program theory for this study. First, an attempt is made to link the differences between the blind and sighted groups on short targets with the difference in the nature of their programming, which is guided in the sighted

3.88 group predominantly by the visual reference system and in the blind group by the kinesthetic sources. However, no attempt is made at this stage to answer how feedback control as well as programming may operate for short movements. Second, given that long movements operate under feedback, it is not surprising to find blind subjects performing better than sighted subjects because they use and depend on kinesthetic cues to a great extent. Finally, to produce a response, the unit that evaluates feedback, namely the template or comparison centre, must receive matching information, for if any mismatch is introduced, as in the case of the curvilinear movements with distance cue, the relative advantage would be lost. The lack of difference between blind and sighted groups in such a case bears testimony to it.

The experiments to follow in this chapter are further explorations into the nature of the role of visual reference system in the processing of linear and curvilinear movements. Wherever necessary a given treatment would be presented on a number of trials and an attempt would be made to compute variable error (VE) which is a measure of within subject consistency. This response measure would be an additional dimension to show the effect of various variables on the strength of trace (Laabs, 1973).

3.89 PRINCIPAL EXPERIMENTS

The results of the pilot work suggest distinct nature of retention for linear and curvilinear movements. As stated earlier, the reason is the distinct spatiotemporal cues involved in the two movement situations. Whereas the linear task involves movement in one direction, the curvilinear task involves a movement situation in which the direction changes at every step. Movement informations, viz. location and distance, were distinctly affected by the delay in recall. Location information was generally more precisely coded and better retained than distance. Another important feature of movement retention emerging from these experiments is the more precise coding and recall of short movements than long movements.

The basic objective of the pilot study was to explore the role of visual reference system in the retention of the abovesaid attributes of movement. Absence of visual schema of the surrounding and of one's own movement in space might make difference in the acquisition and retention of novel movements. This effect was reflected in the difference in retention performance of blind and sighted subjects. This difference was prominent enough on a linear task, but not so significant on a curvilinear task.

Informations failed to appear as a significant variable to determine the contribution of visual reference

3.90 as in case of Hermelin and O'Connor's (1975) experiments. The difference in the two studies was that Hermelin and O'Connor gave a number of trials to the same subject of a given experimental condition to measure intra-subject consistency or variable error (VE) along with absolute (AE) and constant errors (CE), while no such attempt was made in our pilot study. Laabs (1973) suggested that location and distance informations differ in their coding and retention properties and require application of CE and VE, respectively, as response measures. Another reason for the difference between the two studies could be that Hermelin and O'Connor measured retention immediately after learning but in the present study recall was obtained after brief delays which might have weakened the strength of the memory trace. In a sense it seems reasonable to measure variable error before making any generalization about the contribution of visual reference in retention of location and distance informations.

Although researches in the past two decades have produced considerably large amount of data on discrete movements of the blindfolded sighted subjects, little is known about how blind people organize and execute their movements. Studies of blind subjects have produced equivocal results. Lowenfeld (1950) believed that general mobility will be hampered in the blind people. A reference of studies that show difference in the motor performance of

3.91 blind and sighted subjects (Asso and Wyke, 1970; Gregory, 1966; Hartlage, 1969; Senden, 1932; Worchel, 1951) was made earlier. Contrary to it, other studies have shown that blind people suffer only a developmental lag and they recover the deficiency later in life (Fraiberg, 1968; Gomulicki, 1961; Jones, 1965; Leonard and Newman, 1967; Shagan, 1970).

In the three experiments reported in the pilot study no attempt was made to explore the retention of self-defined (preselected) as against experimenter-defined (constrained) movements. In the current literature, it has been shown that preselection leads to more precise coding of movements. Moreover, preselection has also been found useful to code distance information. A major task undertaken here concerns an examination of the role visual reference plays in determining the effectiveness of preselection. In other words, we will now make more specific attempts to explore the nature of coding of movements in the blind people. Experiment 3.4, the first in the series, was conducted to compare blind and sighted subjects on their short term retention of location and distance informations under preselected and constrained movement conditions. Experiment 3.5 deals with the effect of prior learning of locations on the blind subjects' recall of criterion location and distance targets. In Experiment 3.6, the effects of interpolated information processing activity

3.92 (backward counting by threes) and movement was examined on the retention of location and distance targets of the blind and sighted subjects. In Experiment 3.7 an attempt was made to study how interpolated processing activity and movement affect recall of preselected and constrained movements of the blind people. Experiment 3.8 deals with exploration of the phenomenon of response biasing leading to overshooting or undershooting of responses of the blind people. Lastly, in Experiment 3.9 which is an extension of the previous experiment, the effect of responses biasing in recall of preselected and constrained movements has been studied.

EXPERIMENT 3.4

There is lack of unanimity over a clear and precise explanation as to how preselection augments performance. At the academic level two types of views are presented, one based on attention demands, i.e. cognitive, and the other motor. Both have two sources to explain preselection.

One view of cognition mechanism holds that when the subject preselects the criterion movement, more attention is allocated to the task but this concept of increased central capacity in preselection is not valid, though it is likely that this is so prior to initiation of movement. The second cognition based explanation refers to an effective encoding strategy on preselected trials. But a lot of debate is going on concerning the content of such encoding strategy

3.93 and the nature of operations involved, believing at the same time that some efferent component of preselected movement, at least partially, contributes to the preselected effect.

Among explanations based on motor mechanism, Central Monitoring of Efference (CME) and Corollary Discharge have been put forth. The CME, proposed by Jones (1974), holds that efferent commands can be more efficiently monitored and stored and hence provide advantage to preselection. This happens by storing a better copy of efference without peripheral feedback. Unfortunately, this extreme view of preselection is no more favourable as it did not explain the role of spatial factors.

Stelmach and Kelso (1977) viewed that under preselected conditions sensory-processing centers in the central nervous system are prepared to receive peripheral information but this does not happen in nonpreselected condition; hence recall of a preselected task is superior to nonpreselected. A major weakness in this corollary discharge explanation is that it ignores the planning process occurring prior to the generation of support signals.

In a recent partial modification of his theory, Kelso and Wallace (1978) have fallen back on an old but familiar concept of image or plan to bring an eclectic view of preselection by having the main contribution of both cognitive and motor explanations. According to them, 'the role of the image in

3.94 preselected movement is to generate anticipatory signals that prepare the actor to accept certain kinds of information'. ... Perhaps a literal interpretation of corollary discharge might argue that the anticipated consequences are 'left behind' in sensory centers following the generation of movement commands ... The anticipatory signals, then, are the basis on which commands are organized, one of their functions being to serve as a referent for the interpretation of incoming feedback' (p. 105). Explaining further, they write, 'the important implication of this proposal is that when we preselect movement we obtain information that is in terms of our expectation. In a sense, we predict the way things ought to be (in a spatial task, for example, where our limb will terminate) as a result of effecting a movement and hence establish a context for movement-produced information. In constrained movement, however, an appropriate context cannot be specified because no anticipatory image is available.....under preselected voluntary conditions, it can be argued that subjects rely on the internal signal containing the anticipated sensory consequences, rather than on the actual sensory input, which is redundant if the movement has been accurately preplanned' (pp.105-106).

The purpose of this lengthy quotation is to show how, after a long exercise, we have come to a conclusion about the role of image which was considered vital several years

3.95 ago (James, 1890). Needless to say that one would have paid a higher premium for this more reliable and trustworthy scientific inquiry had it not been known recently that terminal limb position may be centrally programmed (Bizzi, et al, 1976; Kelso, 1977b).

A very significant issue brought out by Kelso is that vision does not aid the reproduction accuracy of either constrained or preselected movement but, on the contrary, it tends to have detrimental effect. The possible reason for it being that due to greater central processing requirements of preselection it is not possible for the subject to attend simultaneously to incoming visual information and to execution of the motor plan. To have this he conducted an experiment in which reproduction was by vision only, movement only, or both under preselected-vision informed and uninformed conditions. The superiority of the informed group had led him to argue that the subjects were capable of selectively processing movement information, whereas in the uninformed group they appear to have maintained their attention on vision. In other words, 'prior knowledge of the response modality', they write, 'is effective in reducing the deleterious effects of vision on movement reproduction' (ibid, p. 93).

Kelso's analysis of preselection has raised several important issues particularly in view of his findings and implications on the blind and sighted groups. It would be

3.96 interesting to examine the role preselection plays in the total absence of visual reference system. Therefore it is proposed that

> A preselection cue will lead to precise coding of movements in sighted subjects but not in blind subjects.

Based on AE and CE analyses in the pilot study, it was shown that the blind subjects were inferior to their sighted counterparts in short term reproduction of a location task. On the other hand, though the blind subjects performed inferior to the sighted subjects on short distance targets, this result reversed between these groups with increase in target length. On an immediate reproduction task Hermelin and O'Connor (1975) found that blind and sighted subjects do not differ in reproduction of simple movement and location tasks, while blind subjects were clearly inferior to their sighted counterparts in the reproduction of a distance task. Relatively little is known about blind subjects' ability to use preselection cues in the retention of movements. Roy (1978) has shown that advantage of preselection is dependent on prior information about termination of a movement. This prior information may be used to reproduce distance. He also contended that the effectiveness of this prior information arising out of preselection is helped by availability of a nonmotor system like vision. It is, therefore, contended that :

3.97 Both blind and sighted subjects would take advantage of preselection in the coding of a location target.

In the coding of a distance target preselection would be advantageous to sighted subjects but not to blind subjects.

Method and Procedure

The present investigation deals with memory of discrete motor skill tasks varying in nature, viz., linear-horizontal, linear-vertical and curvilinear. The first two of these involve movement in one direction, e.g., right to left or down to up, respectively. The third one, i.e. curvilinear, involves a movement in which the direction changes at each point. Most investigators have used very simple equipments to study the recall of movements involving variations in the tasks (Adams and Dijkstra, 1966; Bilodeau et al., 1962).

Loss in retention of motor responses was measured in the earlier studies as deviation of reproduction response from the criterion response (Adams and Dijkstra, 1966; Posner and Konick, 1966). Further, these deviations or mismatches were recorded in terms of absolute error (AE) or constant error (CE). AE refers to mean unsigned error, while CE refers to mean signed or algebraic error. A third response measure has also been introduced in the current literature, i.e., variable error (VE). It refers to the

3.98 variance within a subject (Laabs, 1971, 1973) or within a sector (Stelmach and Kelso, 1975). VE amounts to the standard deviation of the algebraic mismatches committed by a subject within the given experimental condition.

Stelmach and Wilson (1970) viewed that "change in AE can arise from changes in CE, VE or a combination of both"(p.426). Laabs (1971) putforward the relation among AE, CV and VE as follows when the variability is small :

$$\text{Average AE} = \sqrt{(CE)^2 + (VE)^2}$$

Moreover, he argued that 'a component decrease in one measure may be compensated by an increase in the other leading to a false conclusion of no change'. In this connection, Schutz and Roy (1972) contended that :

> If researchers persist in using absolute error as a dependent variable in motor performance studies then it should be given its correct interpretation - that is, as a measure of variability about the target or inconsistency in performance when CE is approximately equal to zero. In the situation when constant error is of intermediate magnitude then absolute error is only interpretable when broken down to its two components, constant error and variable error (p.8).

Marteniuk (1973) tested predictions reported in two recent models of motor short term memory (Laabs, 1973; Pepper and Harman, 1970). In Pepper and Harman's model it has been argued that all movement informations decay

3.99 with increase in recall delay period in the negative direction. They adopted CE as measure of decay of traces. Laabs, on the contrary, argued that VE should be taken as a measure of decay because decay causes a weaker trace and it, in turn, increases variability in reproduction of responses. Marteniuk's result revealed that VE could not discriminate among his delay conditions and their interactions with other variables. Therefore, he argued that VE is not a sensitive measure of trace decay and accepted CE in place of VE.

Laabs (1975 b) defended his previous model by the argument that "lack of power is a more plausible explanation for the negative results than the insensitivity of the VE measure" (p. 148). His contention was based on statistical power analysis suggested by Cohen (1969).

Presenting a counter argument on the same issue Marteniuk (1975) remarked that though his data lacked power, as shown by Laabs (1975), power can be only roughly estimated and is probabilistic in nature. According to him, "Cohen (1969) cautions his readers that the calculations of power is an arbitrary exercise in that there is no absolute definition of effect size" (p. 151). Further expressing reservation on Laabs' (1973) model of MSTM, he argues for modification in the model.

3.100 In general, researches reported in this field have generally employed all the three response measures, i.e. AE, VE and CE. In the present series of of experiments also an attempt has been made as far as possible to study all these three response measures.

In MSTM studies mainly blindfolded sighted subjects have been employed to study kinesthetic movements. Simultaneously, attempts have also been made to attenuate or augment the response with various sensory informations or with knowledge of results to examine its effect on motor retention. Use of congenitally blind subjects in MSTM studies started recently as a comparable group (Hermelin and O'Connor, 1975; Shagan, 1970). This group of subjects varied from the previously used blindfolded subjects in terms of their availability, useful visual imagery/schema of the space and their movements in space. It is generally believed that visual imagery is relevant for guiding and controlling movements of sighted subjects even when they remain blindfolded. Methodologically, congenitally blind subjects serve as an ideal matching group for the manipulation of vision in the studies of motor retention.

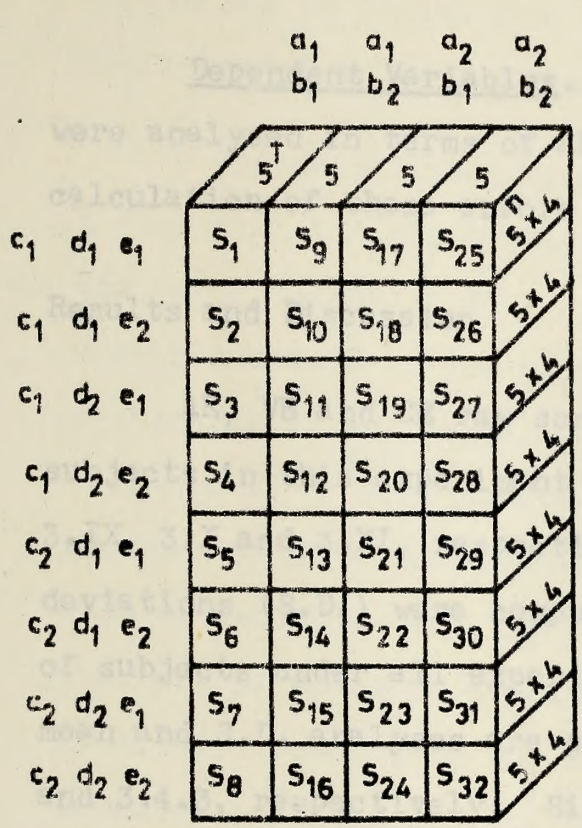
Sample. In this experiment 160 adults (80 congenitally blind and 80 sighted) volunteered as subjects. The age of both blind and sighted subjects ranged between 20 to 30 years, with a mean age of 25 years and 1 month. The two groups were

3.101 also matched for their education and intelligence. The blind subjects were either congenitally blind or had lost total vision soon after birth but had no other mental or physical disability. Because they were not available in one institution, they were selected from nearby places. They were randomly included from the educational institutions and workshops of the blind located in Amravati, Nagpur and Poona districts of Maharashtra. The sighted subjects were also having normal mental and physical health and belonged to the local colleges of the same place. Only righthanded male subjects were included in the sample.

Apparatus and Materials. In this study a linear slide (see Fig. 3.1.1) similar to the one described by Adams and Dijkstra (1966) was used to perform discrete graded hand movements. This consisted of a 55 cm long metal bar mounted with a slide and a stop peg. Special arrangement was made to isolate movement informations with the help of a removable stop peg. It is possible to remove this stop peg as and when required. A centimeter scale was used to gauge the movement according to the need of the experimenter. The movement of the slide on the rod was made smooth and near frictionless by using ball-bearings inside the slide. The retention interval and the intertrial intervals were measured by a stop watch. An opaque goggle was used to blindfold the sighted subjects.

3.102 Experimental Desigh and Procedure. A 2x2x2x2x2 factorial design, having groups (sighted or blind), informations (location or distance), preselection (preselected or constrained) targets (5-10 cm or 20-25 cm) and retention intervals (5 sec or 90 sec) was employed. In each of these 32 experimental conditions 5 new subjects were assigned. Experimental arrangement of this design is shown in Fig. 3.4.1.

The subject was brought to the testing room and was seated comfortably on one side of the table on which the covered apparatus was placed. The seat of the subject was adjusted so that the grip of the linear slide remains in line of his shoulders. The sighted subjects were blind-folded before entering the room. All subjects were given a brief introduction and an attempt was made to practically ensure that they followed the task. The subjects of the preselected group were asked to choose their targets in a given range and recall it upon request. The subjects of the constrained group were requested to move the slide to the targets which were matched by the experimenter against the ones selected by the preselected group. In location condition, a subjects hand was stopped after he had covered half of the length while returning from the criterion target. Subsequently, he reproduced the exact end point of the criterion target. In distance condition, the subject moved from a point which was halfway



a-GROUP
1) SIGHTED
2) BLIND

b-PRESELECTION
1) PRESELECTED
2) CONSTRAINED

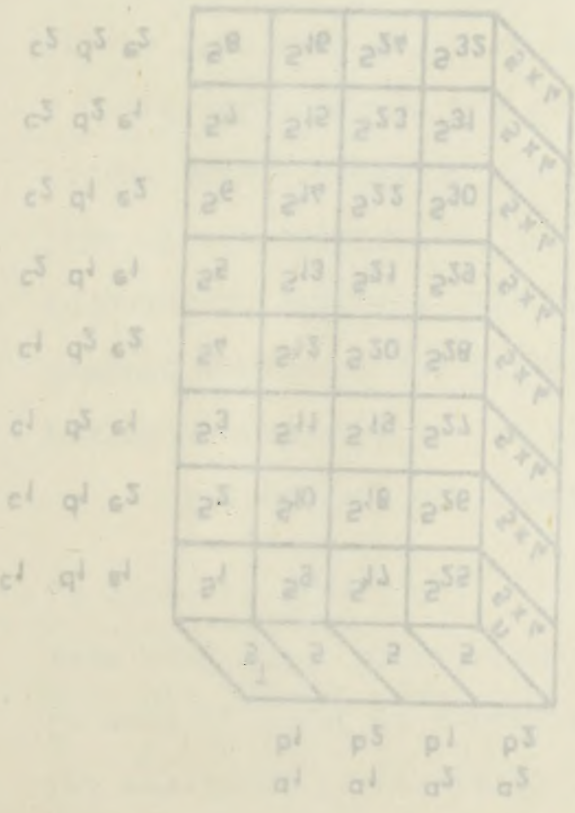
c-INFORMATION
1) LOCATION
2) DISTANCE

d-TARGET
1) SHORT – 5 – 10cm.
2) LONG – 20–25cm.

e-RETENTION INTERVAL
1) 5 sec.
2) 90 sec.

N=160 (SIGHTED = 80 / BLIND = 80)

FIG3.4.1 DESIGN FOR EXPERIMENT 3.4



3.103 between the starting and the criterion points to reproduce the total movement extent. Each subject was given 5 trials of a given experimental treatment with an intertrial interval of 1 minute.

Dependent Variables. The obtained recall errors were analysed in terms of AE, CE and VE. The procedure for calculation of these errors has been described earlier.

Results and Discussion

AE, VE and CE raw scores of the blind and sighted subjects in this experiment are presented in Appendices 3.IX, 3.X and 3.XI, respectively. Means and standard deviations (S.D.) were computed for each independent group of subjects under all experimental conditions. Results of mean and S.D. analyses are presented in Table 3.4.1, 3.4.2 and 3.4.3, respectively. Since these tables involve several subgroups in relation to various experimental conditions, comparative analyses of the performance of the blind and sighted subjects would be more meaningful while discussing the interaction effects. Moreover, AE and VE would be discussed together because both refer to variability. Discussion of CE would follow the discussion of AE and VE to throw light on the directionality of error in the blind and sighted groups.

3.104 A 5 way ANOVA test (2 x 2 x 2 x 2 x 2) consisting of groups x informations x preselection x targets x retention intervals as main variables was employed for each set of AE, VE and CE scores and the results of these analyses are reported in Tables 3.4.4, 3.4.5 and 3.4.6, respectively.

The main effect of groups is significant for AE, F (1,128) = 223.48, $p < .01$; VE, F (1,128) = 32.49, $p < .01$, and CE, F (1,128) = 10.44, $p < .01$. Mean absolute and variable errors of the blind group (2.66 cm and 1.74 cm, respectively) are larger than those of the sighted group (1.65 cm and 1.09 cm). Mean constant errors of the blind and sighted groups are -1.02 cm and -0.48 cm, respectively. These results indicate that the blind subjects are poorer in the accuracy of movement reproduction than the sighted subjects. It is also found that the blind subjects have a strong tendency to underestimate targets than their sighted counterparts. These findings corroborate the finding of previous studies (Hermelin and O'Connor, 1975; Senden, 1932, White et al, 1964; Worchel, 1951).

The two informations, viz., location and distance, differ significantly in the degree of precision in coding: AE, F (1,128) = 890.34, $p < .01$; VE, F (1,128) = 92.50, $p < .01$; and CE, F (1,128) = 191.22, $p < .01$. Mean AE and VE for location (1.15 cm and 0.86 cm, respectively) are smaller than AE and VE for distance (3.16 cm and 1.97 cm, respectively). Mean CE for location and distance are

3.105

TABLE 3.4.1

MEAN AE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATION AND DISTANCE INFORMATIONS UNDER PRESELECTED/CONSTRAINED MODES (PRE/CON), TARGETS (T) AND RETENTION INTERVAL CONDITIONS (RI)

PRE/CON	T (cm)	RI (sec)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
PRESELECTED						
	5-10	5	0.18 (0.05)	0.55 (0.12)	0.35 (0.13)	1.89 (0.31)
		90	0.27 (Q.04)	0.56 (0.07)	0.45 (0.13)	2.34 (0.78)
	20-25	5	0.72 (0.25)	1.51 (0.13)	1.11 (0.32)	3.76 (0.31)
		90	0.73 (0.08)	1.57 (0.45)	1.11 (0.34)	7.97 (1.05)
CONSTRAINED						
	5-10	5	0.77 (0.14)	2.19 (0.57)	0.84 (0.14)	1.87 (0.21)
		90	1.10 (0.18)	2.86 (0.07)	1.38 (0.42)	2.30 (0.80)
	20-25	5	2.56 (0.16)	2.83 (0.43)	1.98 (0.29)	4.16 (0.29)
		90	2.82 (0.57)	5.25 (0.57)	2.10 (0.13)	8.92 (1.00)

TABLE 3.4.1

MEAN AZ SCORES (IN CM) AND S.D. (IN PARENTHESES) OF SIGHTED AND BLINDFOLD GROUPS IN REPRODUCTION OF LOCATION AND DISTANCE INFORMATIONS UNDER PRESELECTED/CONSTRAINED MODES (PRE/CON), TARGETS (T) AND RETENTION INTERVAL CONDITIONS (RI)

PRE/CON	T (cm)	RI (sec)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
PRESELECTED						
	5		0.18	0.85	0.35	1.89
		5-10	(0.05)	(0.15)	(0.13)	(0.31)
	50		0.27	0.56	0.46	2.84
			(0.04)	(0.07)	(0.13)	(0.78)
	5		0.78	1.51	1.11	3.76
		50-55	(0.25)	(0.15)	(0.39)	(0.31)
	50		0.73	1.87	1.11	7.87
			(0.08)	(0.45)	(0.34)	(1.05)
CONSTRAINED						
	5		0.77	2.19	0.84	1.87
		5-10	(0.14)	(0.57)	(0.14)	(0.21)
	50		1.10	2.86	1.38	9.40
			(0.18)	(0.07)	(0.49)	(0.80)
	5		2.52	2.84	1.00	1.16
		50-55	(0.16)	(0.15)	(0.28)	(0.29)
	50		2.82	6.56	2.10	8.92
			(0.57)	(0.57)	(0.13)	(1.00)

3.106

TABLE 3.4.2

MEAN VE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATION AND DISTANCE INFORMATIONS UNDER PRESELECTED/CONSTRAINED MODES (PRE/CON), TARGETS (T) AND RETENTION INTERVAL CONDITIONS (RI)

PRE/CON	T (cm)	RI (sec)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
PRESELECTED						
	5-10	5	0.24 (0.03)	0.58 (0.10)	0.29 (0.10)	1.89 0.25)
		90	0.27 (0.08)	0.54 (0.17)	0.32 (0.18)	2.17 (0.65)
	20-25	5	0.64 (0.31)	0.93 (0.26)	0.90 (0.29)	3.16 (1.66)
		90	0.75 (0.05)	1.31 (0.39)	0.79 (0.55)	4.43 (2.66)
CONSTRAINED						
	5-10	5	0.44 (0.16)	1.93 (0.46)	0.78 (0.18)	1.36 (0.37)
		90	0.84 (0.27)	1.96 (0.90)	0.77 (0.36)	2.42 (0.96)
	20-25	5	1.51 (0.50)	1.54 (0.97)	1.57 (0.56)	1.52 (0.77)
		90	1.98 (0.61)	1.93 (0.63)	1.69 (0.63)	3.81 (0.50)

3.107

TABLE 3.4.3

MEAN CE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATION AND DISTANCE INFORMATIONS UNDER PRESELECTED/CONSTRAINED MODES (PRE/CON), TARGETS (T) AND RETENTION INTERVAL CONDITIONS (RI)

PRE/CON	T (cm)	RI (sec)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
PRESELECTED						
	5-10	5	0.04 (0.04)	-0.04 (0.23)	0.16 (0.23)	-0.53 (0.31)
		90	0.09 (0.18)	-0.22 (0.33)	0.25 (0.34)	0.90 (1.09)
	20-25	5	-0.06 (0.55)	-1.40 (0.19)	0.53 (0.79)	-2.23 (1.55)
		90	-0.21 (0.26)	-0.77 (1.06)	-0.44 (0.82)	-6.91 (1.96)
CONSTRAINED						
	5-10	5	0.70 (0.13)	0.77 (1.40)	0.33 (0.46)	0.97 (1.33)
		90	0.67 (0.65)	-0.22 (2.35)	1.22 (0.49)	-0.12 (0.47)
	20-25	5	0.35 (2.42)	-2.40 (0.29)	1.29 (0.56)	-4.04 (0.54)
		90	0.23 (2.35)	-5.25 (0.57)	1.22 (0.96)	-8.92 (1.00)

3.108

TABLE 3.4.4

SUMMARY OF ANOVA OBTAINED FOR AE IN EXPERIMENT 3.4

Source	Ss	df	MS	F	p
Main effects	422.34	5	84.47	468.63	.01
Groups (G)	40.28	1	40.28	223.48	.01
Informations (I)	160.48	1	160.48	890.34	.01
Preselection (P)	55.74	1	55.74	309.26	.01
Targets (T)	133.08	1	133.08	738.31	.01
Retention Interval (R)	32.76	1	32.76	181.75	.01
2-way Interactions	148.34	10	14.83	82.30	.01
G x I	38.65	1	38.65	214.44	.01
G x P	14.81	1	14.81	82.17	.01
G x T	16.28	1	16.28	90.33	.01
G x R	7.12	1	7.12	39.52	.01
I x P	0.41	1	0.41	2.26	-
I x T	29.00	1	29.00	160.90	.01
I x R	20.88	1	20.88	115.84	.01
P x T	4.54	1	4.54	25.20	.01
P x R	3.34	1	3.34	18.53	.01
T x R	13.29	1	13.29	73.76	.01
3-way Interactions	62.53	10	6.25	34.69	.01
G x I x P	4.87	1	4.87	27.03	.01
G x I x T	24.87	1	24.87	137.97	.01
G x I x R	6.87	1	6.87	38.13	.01
G x P x T	0.48	1	0.48	2.64	-

3.109

TABLE 3.4.4 (CONTD.)

Source	Ss	df	MS	F	p
G x P x R	0.92	1	0.92	5.13	.05
G x T x R	5.43	1	5.43	30.14	.01
I x P x T	0.04	1	0.04	0.22	-
I x P x R	0.98	1	0.98	5.44	.05
I x T x R	17.48	1	17.48	96.96	.01
P x T x R	0.59	1	0.59	3.28	-
4-way Interactions	10.32	5	2.06	11.45	.01
G x I x P x T	0.92	1	0.92	5.09	.05
G x I x P x R	1.02	1	1.02	5.65	.05
G x I x T x R	6.99	1	6.99	38.77	.01
G x P x T x R	0.34	1	0.34	1.90	-
I x P x T x R	1.05	1	1.05	5.82	.05
5-way Interactions	0.10	1	0.10	0.53	-
G x I x P x T x R	0.10	1	0.10	0.53	-
Explained	643.62	31	20.76	115.19	.01
Residual	23.07	128	0.18		
Total	666.69	159	4.19		

3.110

TABLE 3.4.5

SUMMARY OF ANOVA OBTAINED FOR VE IN EXPERIMENT 3.4

Source	Ss	df	MS	F	p
Main effects	101.61	5	20.32	38.39	.01
Groups (G)	17.20	1	17.20	32.49	.01
Informations (I)	48.96	1	48.96	92.50	.01
Preselection (P)	7.25	1	7.25	13.69	.01
Targets (T)	21.20	1	21.20	40.05	.01
Retention Intervals (R)	7.01	1	7.01	13.24	.01
2-way Interactions	34.91	10	3.49	6.60	.01
G x I	14.38	1	14.38	27.16	.01
G x P	7.47	1	7.47	14.10	.01
G x T	2.59	1	2.59	4.90	.05
G x R	1.59	1	1.59	3.00	-
I x P	2.40	1	2.40	4.53	.05
I x T	0.00	1	0.00	0.00	-
I x R	3.32	1	3.32	6.27	.05
P x T	0.38	1	0.38	0.71	-
P x R	1.24	1	1.24	2.35	-
T x R	1.55	1	1.55	2.92	-
3-way Interactions	20.33	10	2.03	3.84	.01
G x I x P	6.03	1	6.03	11.40	.01
G x I x T	3.44	1	3.44	6.49	.01
G x I x R	4.09	1	4.09	7.73	.01
G x P x T	0.20	1	0.20	0.39	-

SUMMARY OF ANOVA OBTAINED FOR VS IN EXPERIMENT 3.4

Source	SS	df	MS	F	p
Main effects	101.61	3	50.32	36.36	.01
Groups (G)	17.20	1	17.20	32.42	.01
Informations (I)	48.96	1	48.96	92.80	.01
Preselection (P)	7.25	1	7.25	13.69	.01
Targets (T)	21.20	1	21.20	40.06	.01
Retention Intervals (R)	7.01	1	7.01	13.24	.01
2-way Interactions	34.91	10	3.49	6.60	.01
G x I	14.36	1	14.36	27.18	.01
G x P	7.47	1	7.47	14.10	.01
G x T	2.59	1	2.59	4.90	.05
G x R	1.59	1	1.59	3.00	-
I x P	2.40	1	2.40	4.53	.05
I x T	0.00	1	0.00	0.00	-
I x R	3.32	1	3.32	6.27	.05
P x T	0.38	1	0.38	0.71	-
P x R	1.24	1	1.24	2.36	-
T x R	1.85	1	1.85	3.50	-
3-way Interactions	20.33	10	2.03	3.84	.01
G x I x P	6.03	1	6.03	11.40	.01
G x I x T	3.44	1	3.44	6.49	.01
G x I x R	4.09	1	4.09	7.73	.01
G x P x T	0.20	1	0.20	0.38	-

3.111

TABLE 3.4.5 (CONTD.)

Source	Ss	df	Ms	F	p
G x P x R	0.22	1	0.22	0.42	-
G x T x R	0.27	1	0.27	0.50	-
I x P x T	4.65	1	4.65	8.79	.01
I x P x R	0.14	1	0.14	0.27	-
I x T x R	1.25	1	1.25	2.37	-
P x T x R	0.03	1	0.03	0.06	-
4-way Interactions	1.26	5	0.25	0.48	-
G x I x P x T	0.01	1	0.01	0.02	-
G x I x P x R	0.80	1	0.80	1.52	-
G x I x P x R	0.40	1	0.40	0.76	-
G x P x T x R	0.05	1	0.05	0.10	-
I x P x T x R	0.00	1	0.00	0.00	-
5-way Interactions	0.00	1	0.00	0.00	-
G x I x P x T x R	0.00	1	0.00	0.00	-
Explained	158.11	31	5.10	9.64	.01
Residual	67.75	128	0.53		
Total	225.87	159	1.42		

3.112

TABLE 3.4.6

SUMMARY OF ANOVA OBTAINED FOR CT IN EXPERIMENT 3.4

Source	Ss	df	MS	F	p
Main effects	430.04	5	86.01	77.83	.01
Groups (G)	11.54	1	11.54	10.44	.01
Informations (I)	211.32	1	211.32	191.22	.01
Preselection (P)	0.86	1	0.86	0.78	-
Targets (T)	180.37	1	180.37	163.21	.01
Retention Intervals (R)	25.95	1	25.95	23.48	.01
2-way Interactions	325.88	10	32.59	29.49	.01
G x I	30.94	1	30.94	28.00	.01
G x P	1.23	1	1.23	1.11	-
G x T	20.19	1	20.19	18.27	.01
G x R	5.00	1	5.00	4.52	.05
I x P	29.21	1	29.21	26.43	.01
I x T	169.08	1	169.08	153.00	.01
I x R	23.59	1	23.59	21.35	.01
P x T	14.71	1	14.71	13.31	.01
P x R	4.50	1	4.50	4.07	.05
T x R	27.42	1	27.42	24.82	.01
3-way Interactions	106.39	10	10.64	9.63	.01
G x I x P	0.00	1	0.00	0.00	-
G x I x T	35.34	1	35.34	31.98	.01
G x I x R	5.69	1	5.69	5.15	.05

3.112

TABLE 3.4.8

SUMMARY OF ANOVA OBTAINED FOR CT IN EXPERIMENT 3.4

Source	Ss	df	MS	F	p
Main effects	430.04	5	86.01	77.83	.01
Groups (G)	11.54	1	11.54	10.44	.01
Informations (I)	211.32	1	211.32	191.22	.01
Preselection (P)	0.86	1	0.86	0.78	-
Targets (T)	180.37	1	180.37	163.21	.01
Retention Intervals (R)	25.95	1	25.95	23.48	.01
2-way Interactions	325.88	10	32.59	29.49	.01
G x I	30.94	1	30.94	28.00	.01
G x P	1.25	1	1.25	1.13	-
G x T	20.19	1	20.19	18.27	.01
G x R	8.00	1	8.00	7.24	.05
I x P	29.21	1	29.21	26.43	.01
I x T	189.08	1	189.08	171.09	.01
I x R	25.59	1	25.59	23.16	.01
P x T	14.71	1	14.71	13.31	.01
P x R	4.50	1	4.50	4.07	.05
T x R	27.42	1	27.42	24.81	.01
3-way Interactions	106.39	10	10.64	9.63	.01
G x I x P	0.00	1	0.00	0.00	-
G x I x T	35.34	1	35.34	31.98	.01
G x I x R	6.69	1	6.69	6.05	.05

5.113

TABLE 3.4.6 (CONTD.)

Source	Ss	df	MS	F	p
G x P x T	2.13	1	2.13	1.92	-
G x P x R	1.71	1	1.71	1.54	-
G x T x R	17.48	1	17.48	15.81	.01
I x P x T	20.56	1	20.56	18.61	.01
I x P x R	11.75	1	11.75	10.63	.01
I x T x R	11.73	1	11.73	10.61	.01
P x T x R	0.00	1	0.00	0.00	-
4-way Interactions	11.91	5	2.38	2.16	-
G x I x P x T	0.02	1	0.02	0.02	-
G x I x P x R	0.01	1	0.01	0.00	-
G x I x T x R	7.94	1	7.94	7.18	.01
G x P x T x R	3.89	1	3.89	3.52	-
I x P x T x R	0.05	1	0.05	0.05	-
5-way Interactions	3.88	1	3.88	3.51	-
G x I x P x T x R	3.88	1	3.88	3.51	-
Explained	873.10	31	28.33	25.63	0.01
Residual	141.46	128	1.11		
Total	1019.55	159	6.41		

3.114 0.40 cm and -1.90 cm, respectively. It is clear from the results that location information is more precisely coded than distance. Reproduction of location generally led to overestimation of targets, while reproduction of distance resulted in underestimation. Similar findings have also been reported in a number of previous studies (Hermelin and O'Connor, 1975; Laabs, 1973; Marteniuk and Roy, 1972; Marteniuk et al, 1972).

The effect of preselection is significant for AE, F (1,128) = 309.26, $p < .01$; and VE, F (1,128) = 13.69, $p < .01$. Mean AE for preselected movements (1.57 cm) is smaller than mean AE for constrained movements (2.75 cm). It is also found that mean VE for constrained movements (1.63 cm) is larger than mean VE for preselected movements (1.20 cm). This effect is not significant in CE analysis and it indicates that the recall errors for preselected and constrained movements do not differ in the nature of directional shift. These findings provide support to the contention that preselection would facilitate coding and retention of movement. Though Jones (1972, 1974), Roy (1978) and Stelmach et al (1975) differ in their explanations of underlying neurophysiological mechanisms for preselection, they all agree that preselected movements are better reproduced than constrained ones.

3.115 The main effect of targets is significant for all the three response measures: AE, F (1,128) = 738.31, $p < .01$; VE, F (1,128) = 40.05, $p < .01$; and CE, F (1,128) = 163.21, $p < .01$. Mean AE and VE for short targets (1.24 cm and 1.05 cm, respectively) is smaller than mean AE and VE for long targets (3.07 cm and 1.78 cm, respectively). CE analysis also reveals an identical trend of data, i.e. mean CE for short and long targets are 0.31 cm and -1.81 cm, respectively. These results indicate that short targets are more precisely coded and less variable at recall than long targets. Moreover, short targets are overestimated and long targets are underestimated. AE and VE results show precise coding of short movements. Similar results have also been reported in previous studies (Adams and Dijkstra, 1966; Hermelin and O'Connor, 1975; Posner and Keele, 1969). According to Klapp (1975), short movements are preprogrammed and yield superior coding, storage and retrieval. Results obtained in CE analysis yield support to the classical central tendency effect (Hollingworth, 1909; Laabs, 1973) or the range effect (Elson and Wheeler, 1947; Peeper and Herman, 1970).

Length of retention intervals is also a crucial variable in movement reproduction: AE, F (1,128) = 181.75, $p < .01$; VE, F (1,128) = 13.24, $p < .01$; and CE, F (1,128) = 23.48, $p < .01$. Mean AE and VE for the short delay

3.116 condition are 1.70 cm and 1.21 cm, respectively; while for the long delay these scores increase to 2.61 cm and 1.62 cm, respectively. Mean CE for the short and long delays are -0.35 cm and -1.17 cm, respectively. These results show that, with the increase in length of retention interval, coding becomes less precise and more variable. Moreover, the errors shift in a negative direction with increase in delay in recall. Loss of kinesthetic information over unfilled delays has been reported in previous studies (Adams and Dijkstra, 1966; Adams et al, 1972 b; Adams et al, 1972 a; Stelmach, 1969 a, 1969 b). CE yield similar results to that of Faust-Adams (1972) who contended that movements are increasingly underestimated with the increase in length of retention intervals.

Tables 3.4.4, 3.4.5 and 3.4.6 show that a number of first order interaction effects are significant. The groups x informations effect is significant in all the three error analyses: AE, F (1,128) = 214.44, $p < .01$; VE, F (1,128) = 27.16, $p < .01$; and CE, F (1,128) = 28.00, $p < .01$. This interaction effect for AE, VE and CE data have been plotted in Fig. 3.4.2. The histograms for absolute and variable errors show that the blind and sighted subjects do not differ in reproduction of location but the two groups differ in reproduction of distance. The blind group shows more AE and VE than the sighted group in reproduction of distance. The main implication of this

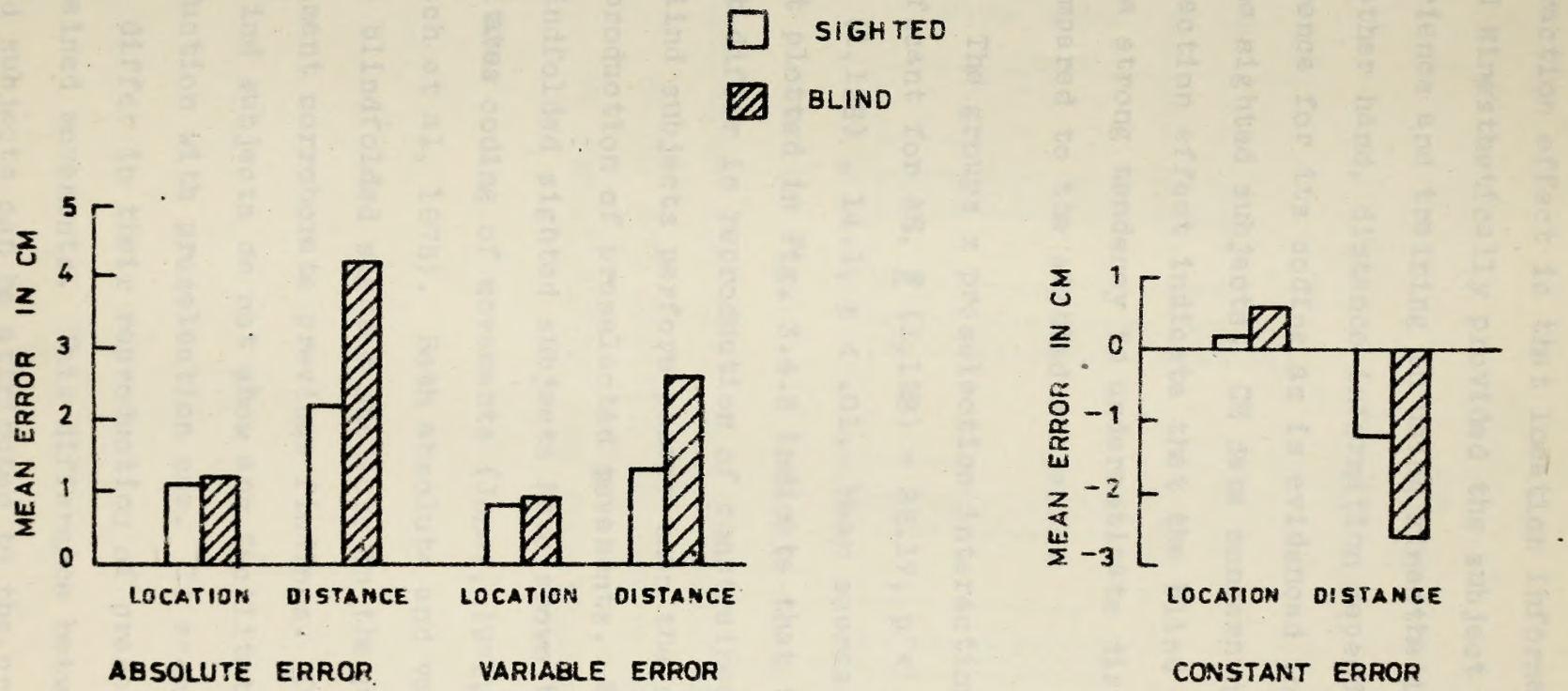
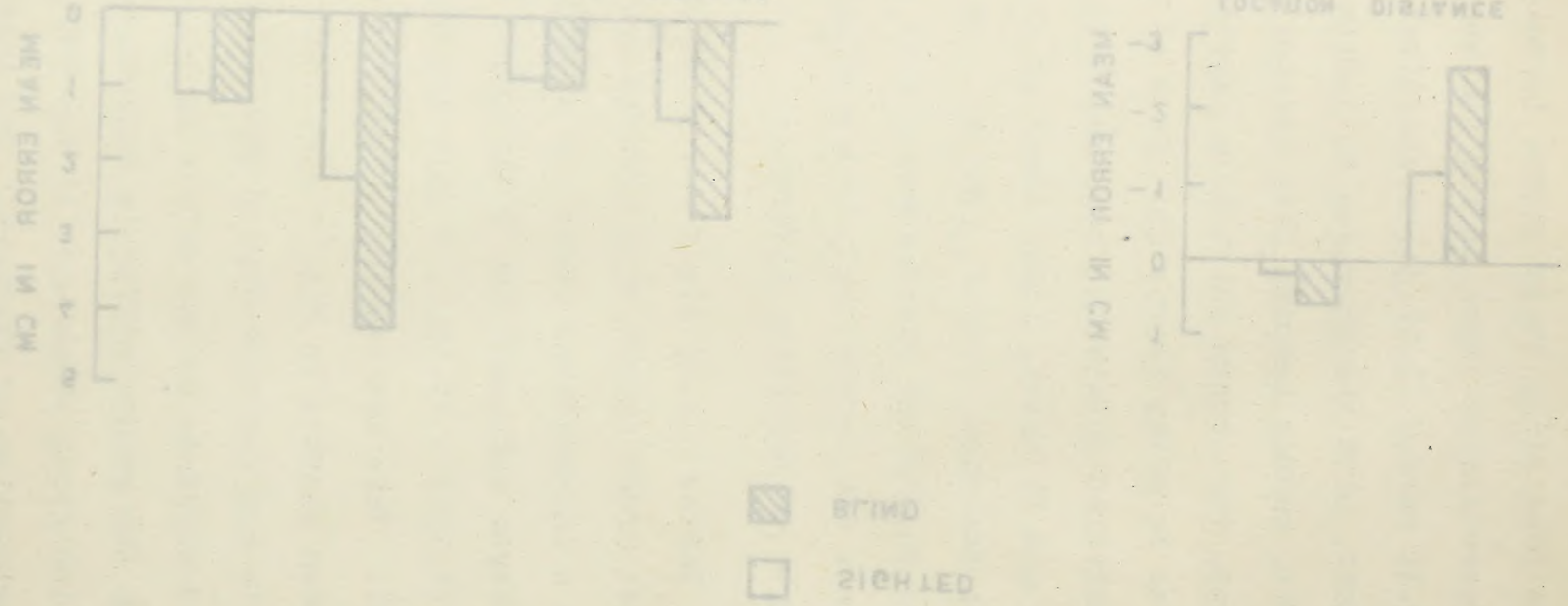


FIG.3.2 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATION AND DISTANCE INFORMATIONS


BLIND
SIGHTED

3.117 interaction effect is that location information could be coded kinesthetically provided the subject has sufficient experience and training in using kinesthetic modality. On the other hand, distance information depends on visual reference for its coding as is evidenced in better performance of the sighted subjects. CE data concerning this interaction effect indicate that the blind subjects have a strong tendency to underestimate distance targets as compared to the sighted subjects.

The groups x preselection interaction effect is significant for AE, F (1,128) = 82.17, $p < .01$; and VE, F (1,128) = 14.1, $p < .01$. Mean scores for this effect plotted in Fig. 3.4.3 indicate that the two groups do not differ in reproduction of constrained movements but the blind subjects perform poorer than the sighted subjects in reproduction of preselected movements. Earlier studies on blindfolded sighted subjects have shown that preselection facilitates coding of movements (Jones, 1972, 1974; Roy, 1978; Stelmach et al, 1975). Both absolute and variable errors of the blindfolded sighted subjects in the present experiment corroborate previous findings. On the contrary, the blind subjects do not show any facilitation in reproduction with preselection cue. It seems that they do not differ in their reproduction of preselected and constrained movements. This difference between blind and sighted subjects can be attributed to the prior visual

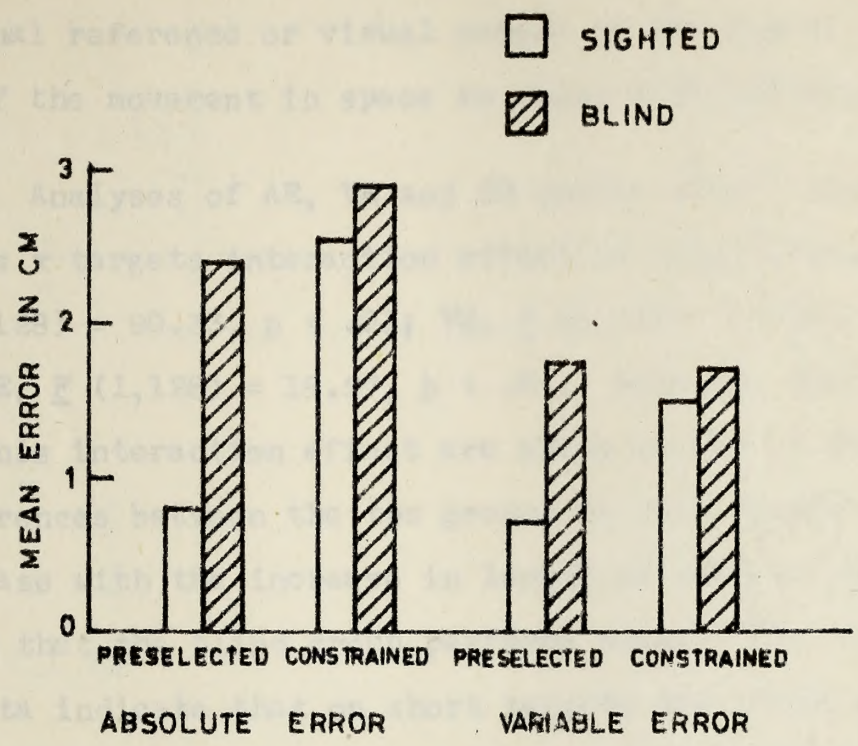


FIG.3.43 MEAN ABSOLUTE AND VARIABLE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS

FIG. 3. MEAN ABSOLUTE AND VARIABLE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS

3.118 experience of the sighted subjects. It could be remarked that planning based on preselection information requires a visual reference or visual schema of the layout in space and of the movement in space to cause a facilitatory effect.

Analyses of AE, VE and CE scores reveal that the groups x targets interaction effect is significant: AE, F (1,128) = 90.33, $p < .01$; VE, F (1,128) = 4.90, $p < .05$; and CE, F (1,128) = 18.27, $p < .01$. Mean AE, VE and CE for this interaction effect are shown in Fig. 3.4.4. The differences between the two groups in both AE and VE increase with the increase in length of targets and it is found that the blind group performs poorer than the sighted. CE data indicate that on short targets the blind subjects show more overestimation than the sighted subjects; while on the long targets the blind subjects show a strong tendency to underestimate than the sighted. This result suggests that a strong central tendency effect is found in the blind subjects as compared to the sighted counterparts.

Analyses of AE and CE indicate a significant effect on the groups x retention intervals interaction: AE, F (1,128) = 39.52, $p < .01$, and CE, F (1,128) = 4.52, $p < .05$. Mean AE and CE scores for this interaction appear in Fig. 3.4.5 which shows that recall accuracy of the blind subjects deteriorates faster than those in the sighted group as the length of retention intervals is increased. In terms of CE analysis this effect emerges in the form of an

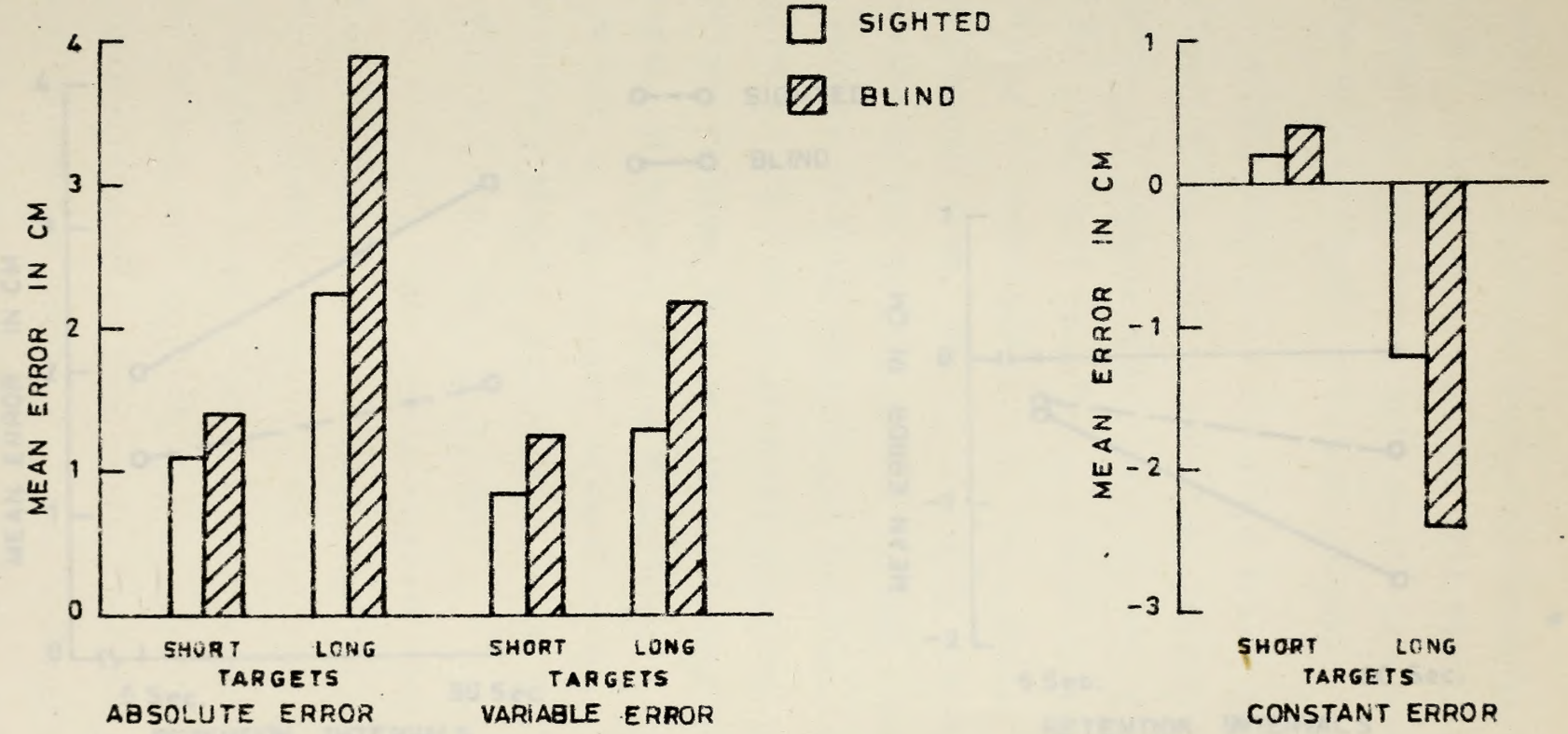


FIG.344 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED SUBJECTS IN REPRODUCTION OF SHORT AND LONG MOVEMENTS

BLIND
SIGHTED
MEAN ERROR IN CM

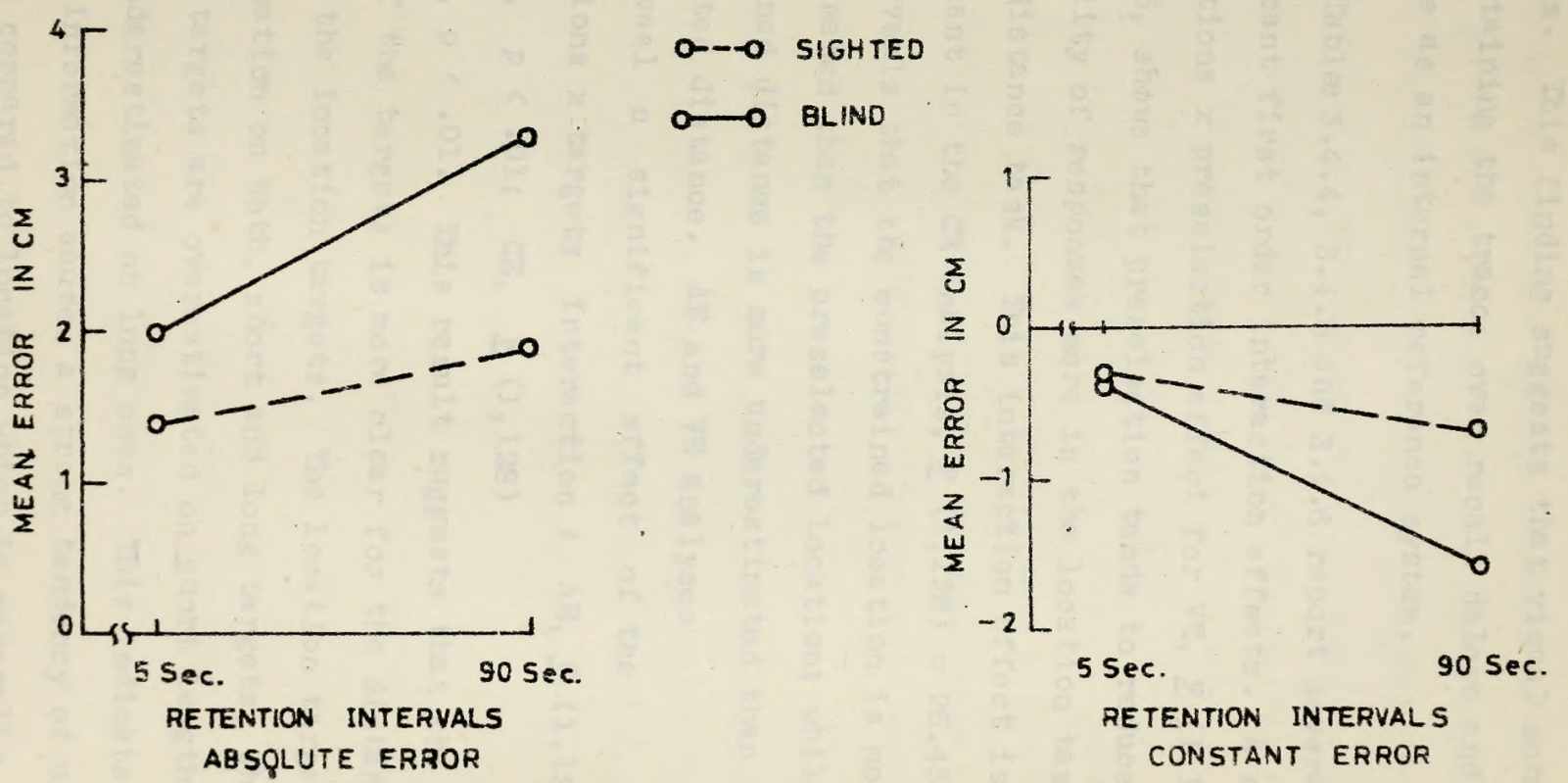


FIG.3.4.5 MEAN ABSOLUTE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF MOVEMENTS OVER RETENTION INTERVALS OF 5- AND 90-SEC.

FIG. 2. MEAN ABSOLUTE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF MOVEMENTS OVER RETENTION INTERVALS OF 5- AND 30-SEC.

3.119 underestimation tendency shown conspicuously by the blind subjects. This finding suggests that visual schema helps in maintaining the traces over recall delays and it seems to serve as an internal reference system.

Tables 3.4.4, 3.4.5 and 3.4.6 report several other significant first order interaction effects. A significant informations x preselection effect for VE, F (1,128) = 4.53, $p < .05$, shows that preselection tends to reduce variability of responses more in the location task than in the distance task. This interaction effect is also significant in the CE analysis, F (1,128) = 26.43, $p < .01$, which reveals that the constrained location is more overestimated than the preselected location; while the constrained distance is more underestimated than the preselected distance. AE and VE analyses also reveal a significant effect of the informations x targets interaction : AE, F (1,128) = 160.90, $p < .01$; CE, F (1,128) = 153.00, $p < .01$. This result suggests that the effect of length of the targets is more clear for the distance targets than for the location targets. The location targets show overestimation on both, short and long targets, while distance targets are overestimated on short lengths but highly underestimated on long ones. This indicates that distance information causes a strong tendency of underestimation as compared to location which is generally overestimated.

3.120 Another interesting interaction effect is informations x retention intervals which is significant for AE, F (1,128) = 115.84, $p < .01$; VE, F (1,128) = 6.27, $p < .05$, and CE, F (1,128) = 21.35, $p < .01$. Both AE and VE data indicate that the location information is retained over unfilled retention interval of 90 sec but distance information is spontaneously lost with increase in length of retention intervals. These findings provide support to Laabs (1973) dual process model of motor short term retention. CE data for this significant interaction reveal that the location targets are generally overestimated, while the distance targets are increasingly underestimated with lapse of time.

The significant preselection x targets interaction for AE, F (1,128) = 25.20, $p < .01$; and CE, F (1,128) = 13.31, $p < .01$ analyses indicate that the adverse effect of target length on precision in coding reduces in the presence of a preselection cue.

The effect of preselection x retention intervals interaction is also significant for AE, F (1,128) = 18.53, $p < .01$, and CE, F (1,128) = 4.07, $p < .05$. These results indicate that constrained movements are more rapidly lost from memory than preselected movements.

3.121 Lastly, the targets x retention intervals interaction effect is also significant in AE, F (1,128) = 73.76, $p < .01$; and CE, F (1,128) = 24.82, $p < .01$. It indicates that recall accuracy for long movements reduces more rapidly than short movements. CE data indicate that long targets are increasingly underestimated with lapse of time, while short movements overestimated.

Several second order interaction effects are significant, a very interesting among these being significant groups x informations x preselection effect: AE, F (1,128) = 27.03, $p < .01$, and VE, F (1,128) = 11.40, $p < .01$. Mean AE and VE scores for this interaction have been plotted in Fig. 3.4.6. Both AE and VE data show similar trends. There is little difference between the blind and the sighted subjects in reproduction of location targets; but the two groups widely differ in reproduction of distance targets, the blind group being poorer than the sighted group. Moreover, this difference between the two groups is stronger in reproduction of preselected distances. A comparative analysis (see Fig. 3.4.6) of preselected and constrained conditions of the sighted group shows that preselection is advantageous for reproduction of both location and distance informations; while the blind group has some advantage of preselection with location information but practically none with distance. These results suggest that a visual reference is required

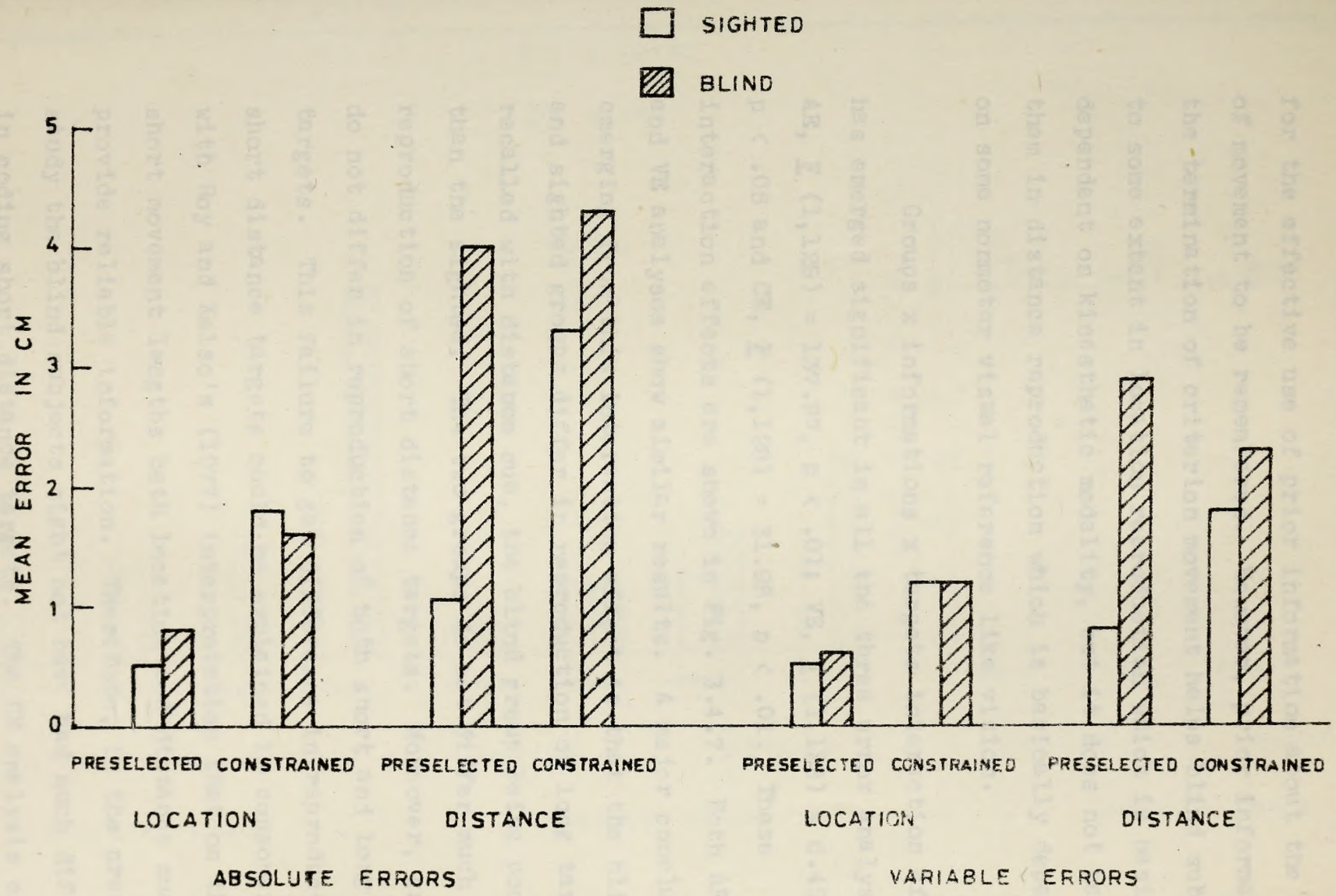


FIG.3.4.6 MEAN ABSOLUTE AND VARIABLE ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES PRESENTED WITH AND WITHOUT PRESELECTION CUE

BLIND
SIGHTED
MEAN ERROR IN CM
0
1
3
5
4
2
DISTANCE
LOCATION
DISTANCE
LOCATION

for the effective use of prior information about the termination
122 of movement to be remembered. However, prior information about the termination of criterion movement helps blind subjects to some extent in location reproduction which is basically dependent on kinesthetic modality, but it does not help them in distance reproduction which is basically dependent on some nonmotor visual reference like vision.

Groups x informations x targets interaction effect has emerged significant in all the three error analyses: AE, $\underline{F}$ (1,128) = 137.97, $p < .01$; VE, $\underline{F}$ (1,128) = 6.49, $p < .05$ and CE, $\underline{F}$ (1,128) = 31.98, $p < .01$. These interaction effects are shown in Fig. 3.4.7. Both AE and VE analyses show similar results. A major conclusion emerging from this interaction effect is that the blind and sighted groups differ in reproduction of long targets recalled with distance cue, the blind group being poorer than the sighted. The two groups do not differ much in reproduction of short distance targets. Moreover, groups do not differ in reproduction of both short and long location targets. This failure to get difference in reproduction of short distance targets could be explained in consonance with Roy and Kelso's (1977) interpretation that on the short movement lengths both location and distance cues provide reliable information. Therefore, in the present study the blind subjects might not have had much difficulty in coding short distance targets. The CE analysis of this interaction effect shows that the blind group underestimated

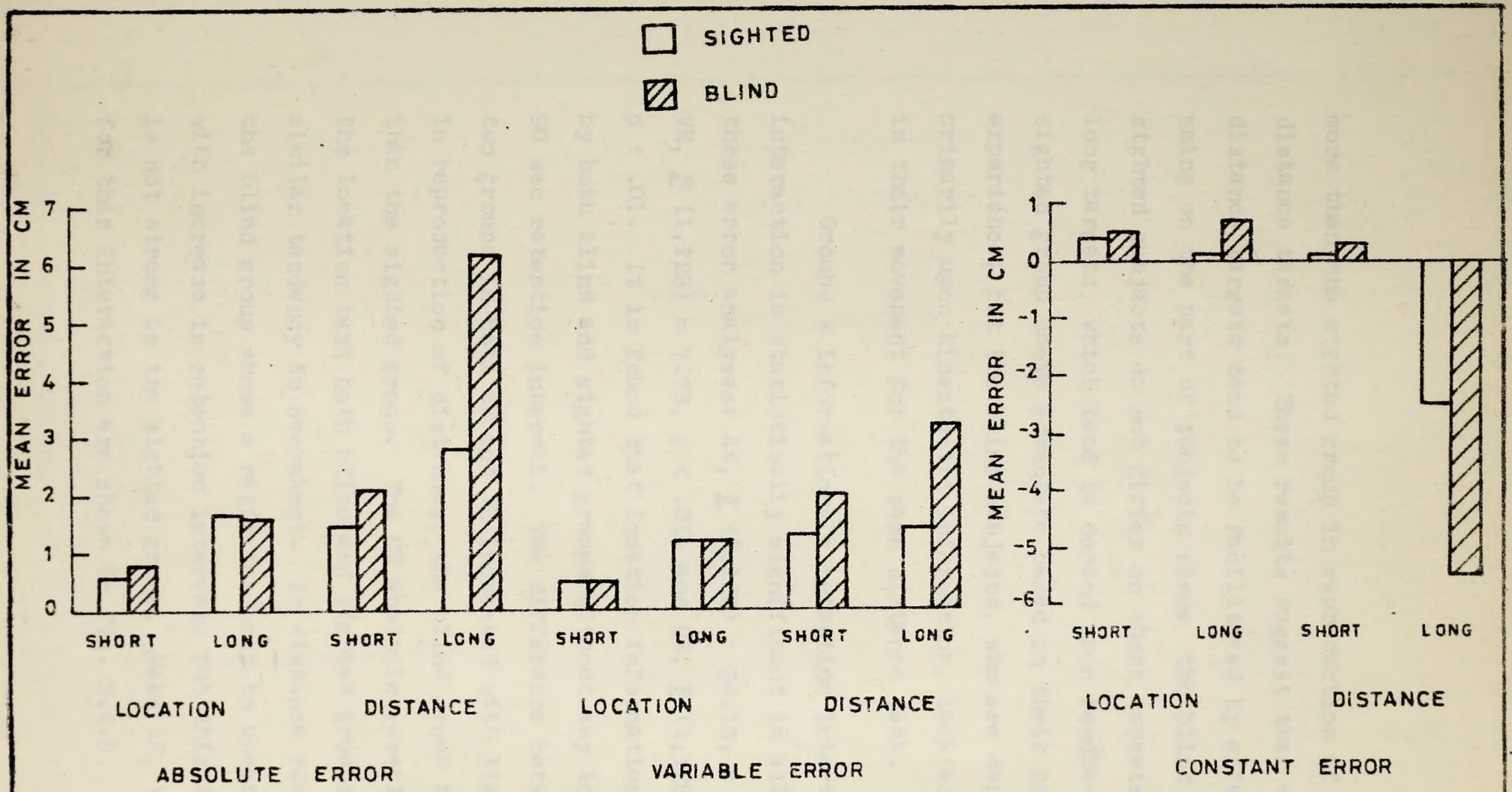


FIG.3.4.7 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF SHORT/LONG LOCATIONS AND DISTANCES

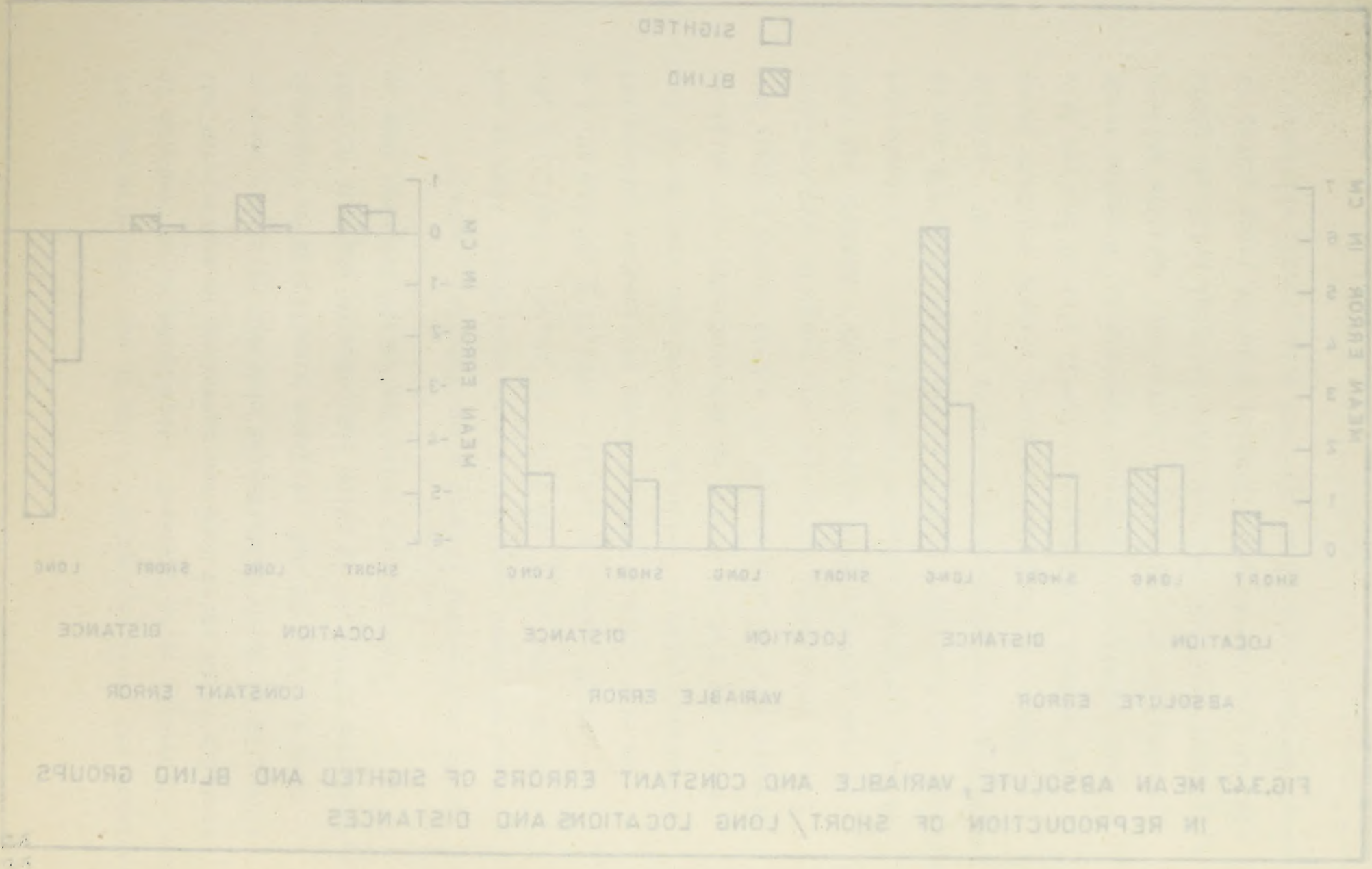


FIG.3.47 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF SHORT/LONG LOCATIONS AND DISTANCES

3.123 more than the sighted group in reproduction of long distance targets. These results suggest that very short distance targets tend to be facilitated by effective programming on the part of subjects since the blind and the sighted subjects do not differ on short targets. On long targets, which tend to depend upon feedback, the sighted group shows advantage based on their prior visual experience; but the blind subjects, who are dependent primarily upon kinesthetic information, lack accuracy in their movement for the same distance task.

Groups x informations x retention intervals interaction is statistically significant in all the three error analyses: AE, $\underline{F}$ (1,128) - 38.13, $p < .01$; VE, $\underline{F}$ (1,128) = 7.73, $p < .01$; and CE, $\underline{F}$ (1,128) = 5.15, $p < .01$. It is found that location information is retained by both blind and sighted groups without any loss at the 90 sec retention interval. The difference between the two groups in both AE and VE increased with time lapse in reproduction of distances, the blind group being poorer than the sighted group. The CE analysis reveals that on the location task both blind and sighted groups show a similar tendency to overshoot. In distance reproduction, the blind group shows a rapid tendency to underestimate with increase in retention intervals but this tendency is not strong in the sighted group. Mean AE, VE and CE for this interaction are shown in Fig. 3.4.8. It is

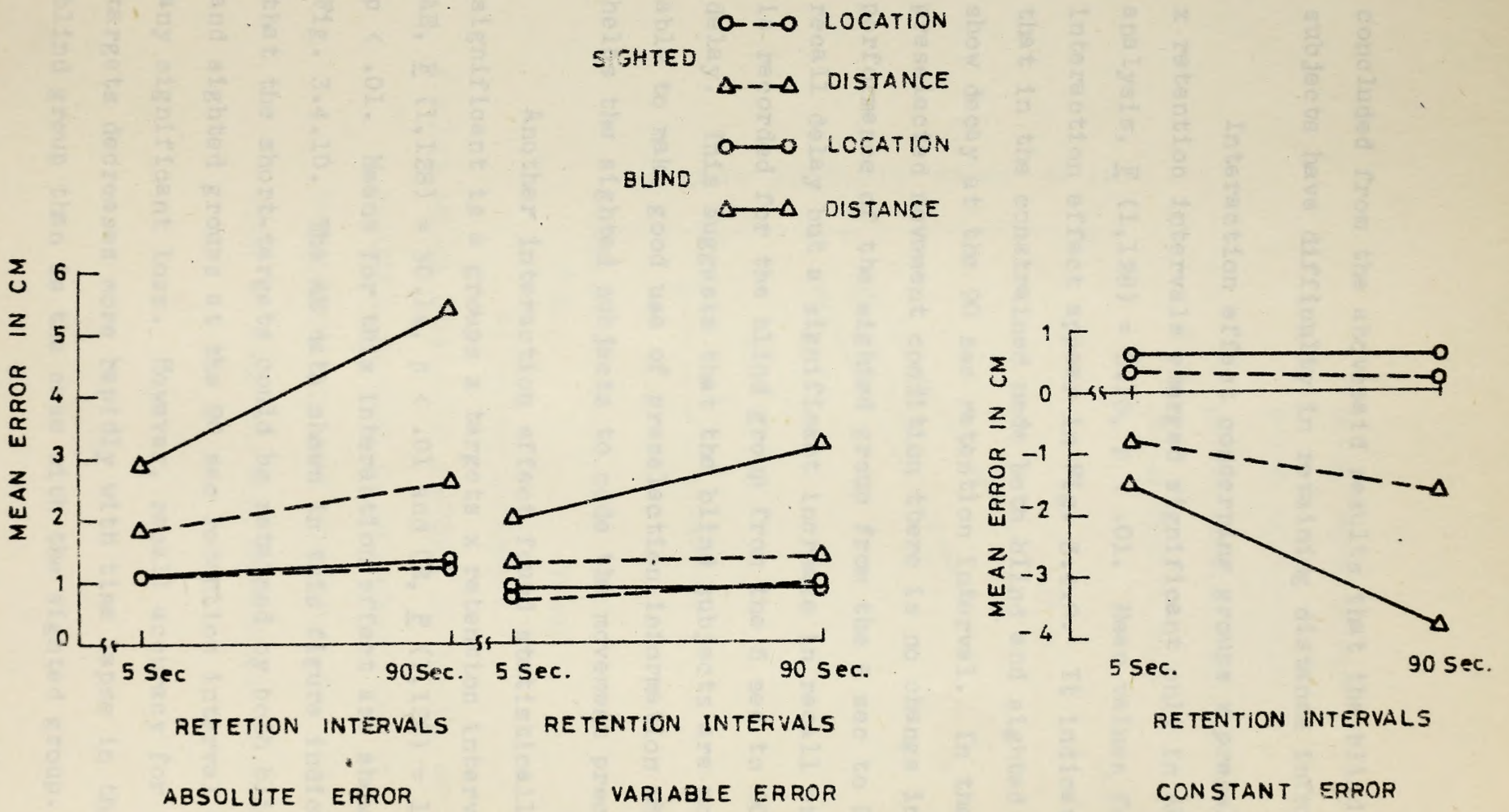
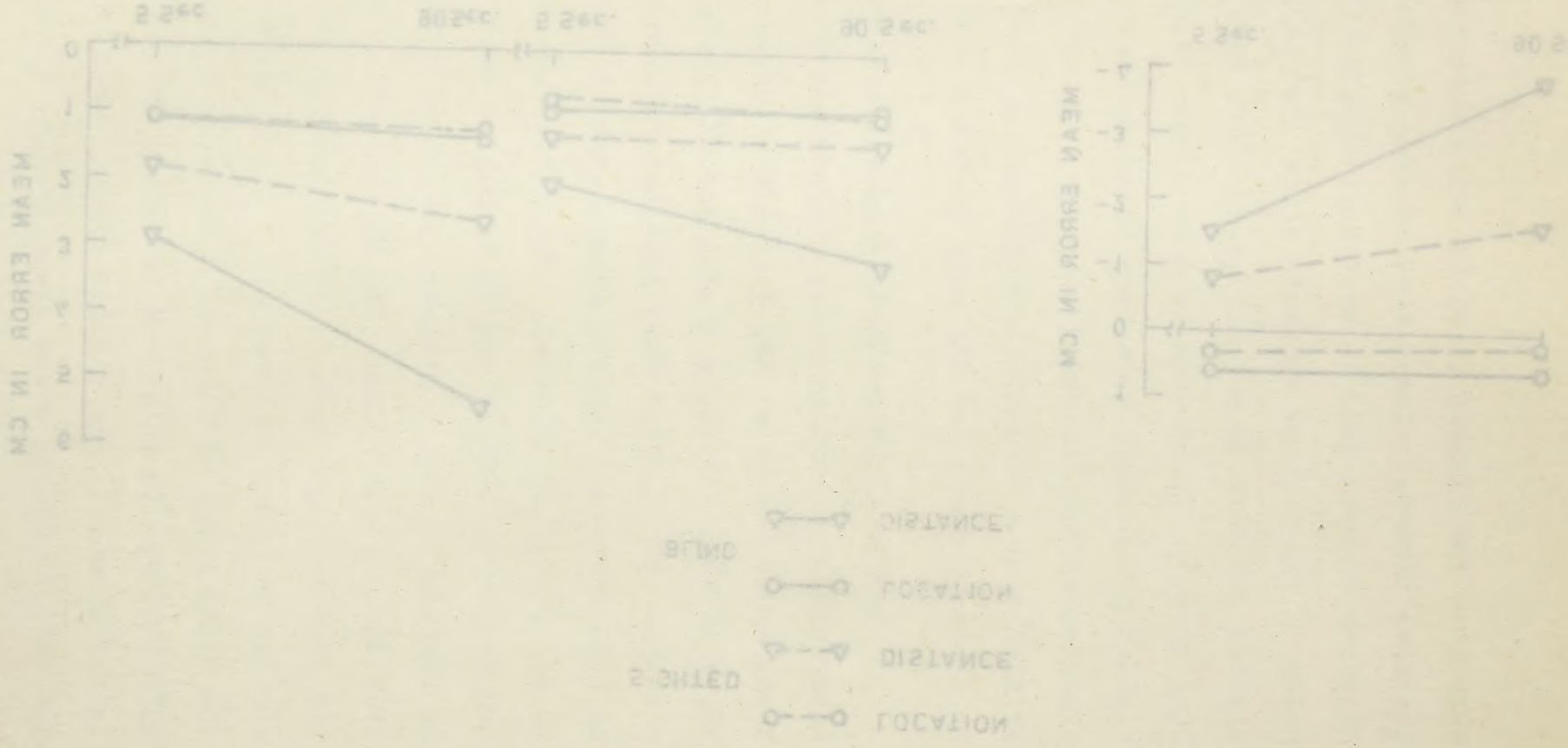


FIG.3.4.8 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES OVER 5- AND 90-SEC. RETENTION INTERVALS


MEAN ERROR IN CM
RETENTION INTERVALS
5 Sec
30 Sec
DISTANCE
LOCATION

3.124 concluded from the abovesaid results that the blind subjects have difficulty in retaining distance information.

Interaction effect concerning groups x preselection x retention intervals emerged significant only in AE analysis, F (1,128) = 5.13, $p < .01$. Mean values for this interaction effect appear in Fig. 3.4.9. It indicates that in the constrained mode both blind and sighted groups show decay at the 90 sec retention interval. In the preselected movement condition there is no change in the performance of the sighted group from the 5 sec to 90 sec recall delay but a significant increase in recall error is recorded for the blind group from the 5 sec to 90 sec delay. This suggests that the blind subjects are not able to make good use of preselection information which helps the sighted subjects to code the movement precisely.

Another interaction effect found statistically significant is a groups x targets x retention intervals: AE, F (1,128) = 30.14, $p < .01$ and CE, F (1,128) = 15.81, $p < .01$. Means for this interaction effect are shown in Fig. 3.4.10. The AE data shown in this figure indicate that the short-targets could be retained by both blind and sighted groups at the 90 sec retention interval without any significant loss. However, recall accuracy for long targets decreases more rapidly with time lapse in the blind group than is the case with the sighted group.

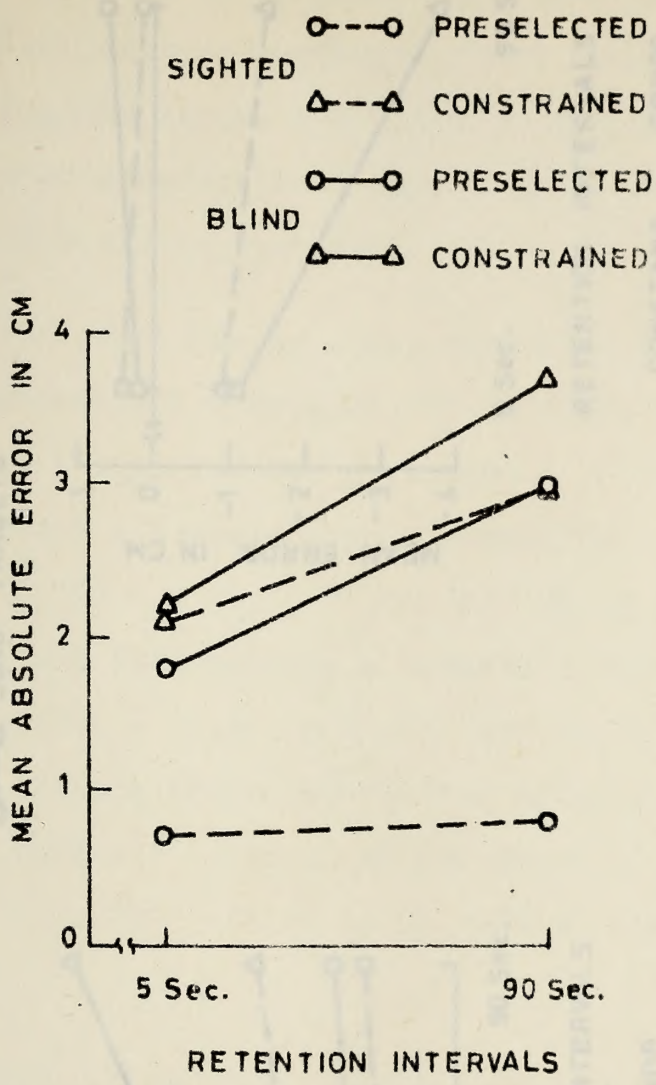


FIG.3.4.9 MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS OVER 5- AND 90-SEC. RETENTION INTERVALS

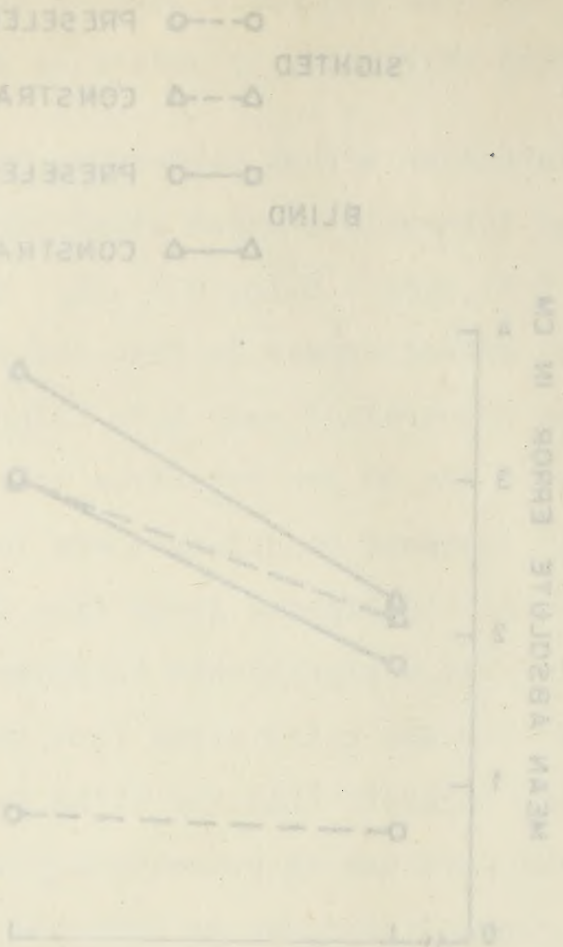


FIGURE 3. MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS OVER 5- AND 30-SEC. RETENTION INTERVALS

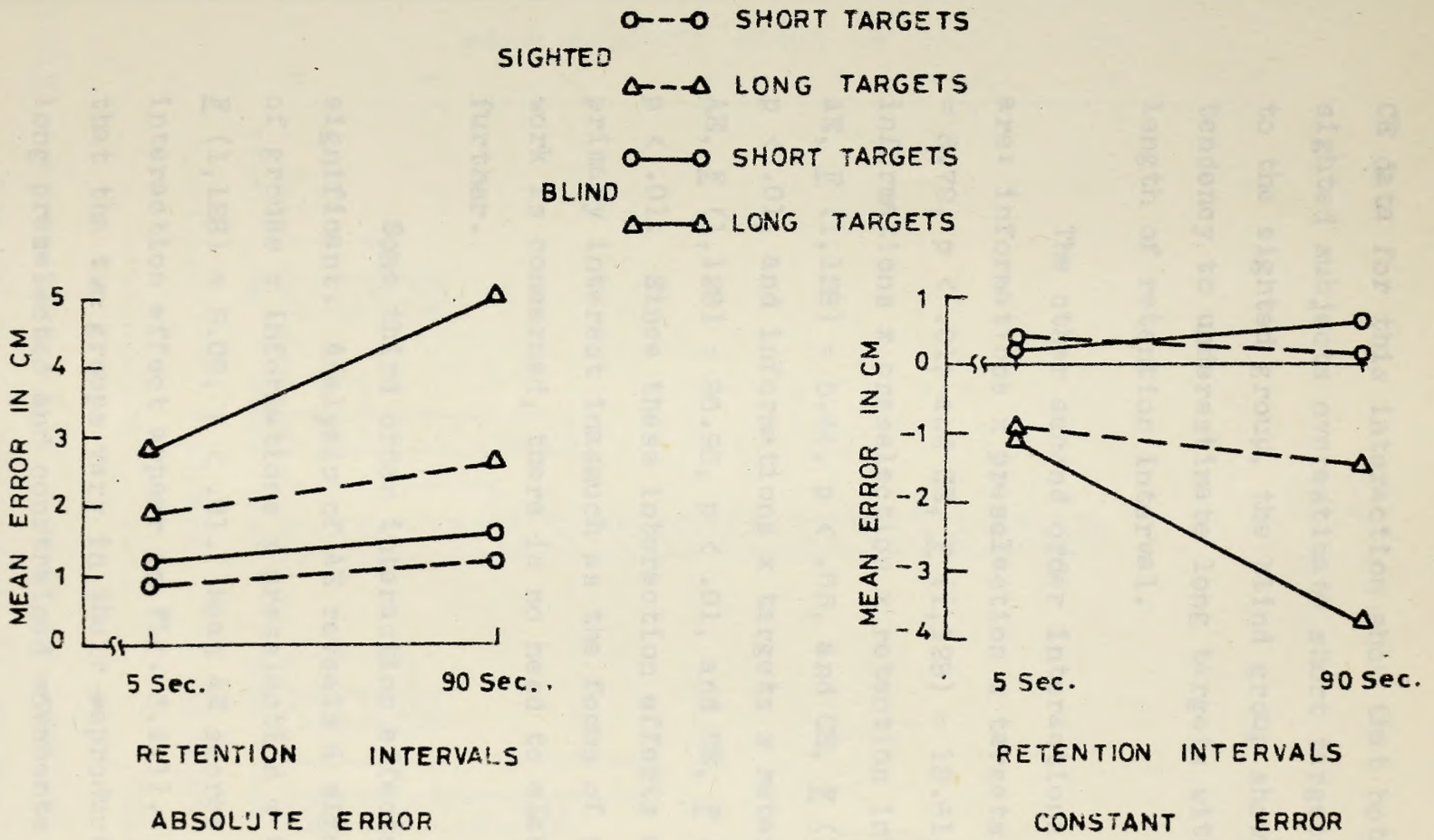


FIG. 3.4.10 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF SHORT AND LONG MOVEMENTS OVER RETENTION INTERVALS OF 5- AND 90-SEC.

FIG. 5 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF SHORT AND LONG MOVEMENTS OVER RETENTION INTERVALS OF .5 AND 30 SEC.

3.125 CE data for this interaction show that both blind and sighted subjects overestimate short targets. As compared to the sighted group, the blind group shows a strong tendency to underestimate long targets with increase in length of retention interval.

The other second order interactions found significant are: informations x preselection x targets, VE, F (1,128) = 8.79, $p < .01$; and CE, F (1,128) = 18.61, $p < .01$; informations x preselection x retention intervals, AE, F (1,128) = 5.44, $p < .05$, and CE, F (1,128) = 10.63, $p < .01$; and informations x targets x retention intervals, AE, F (1,128) = 96.96, $p < .01$, and CE, F (1,128) = 10.61, $p < .01$. Since these interaction effects are not of primary interest inasmuch as the focus of present research work is concerned, there is no need to elaborate them further.

Some third order interaction effects are also significant. Analysis of AE reveals a significant effect of groups x informations x preselection x targets: F (1,128) = 5.09, $p < .01$. Mean AE scores for this interaction effect appear in Fig. 3.4.11. It indicates that the two groups vary in their reproduction of short/long preselected and constrained movements studied in location and distance conditions. The two groups do not differ in reproduction of short preselected and short

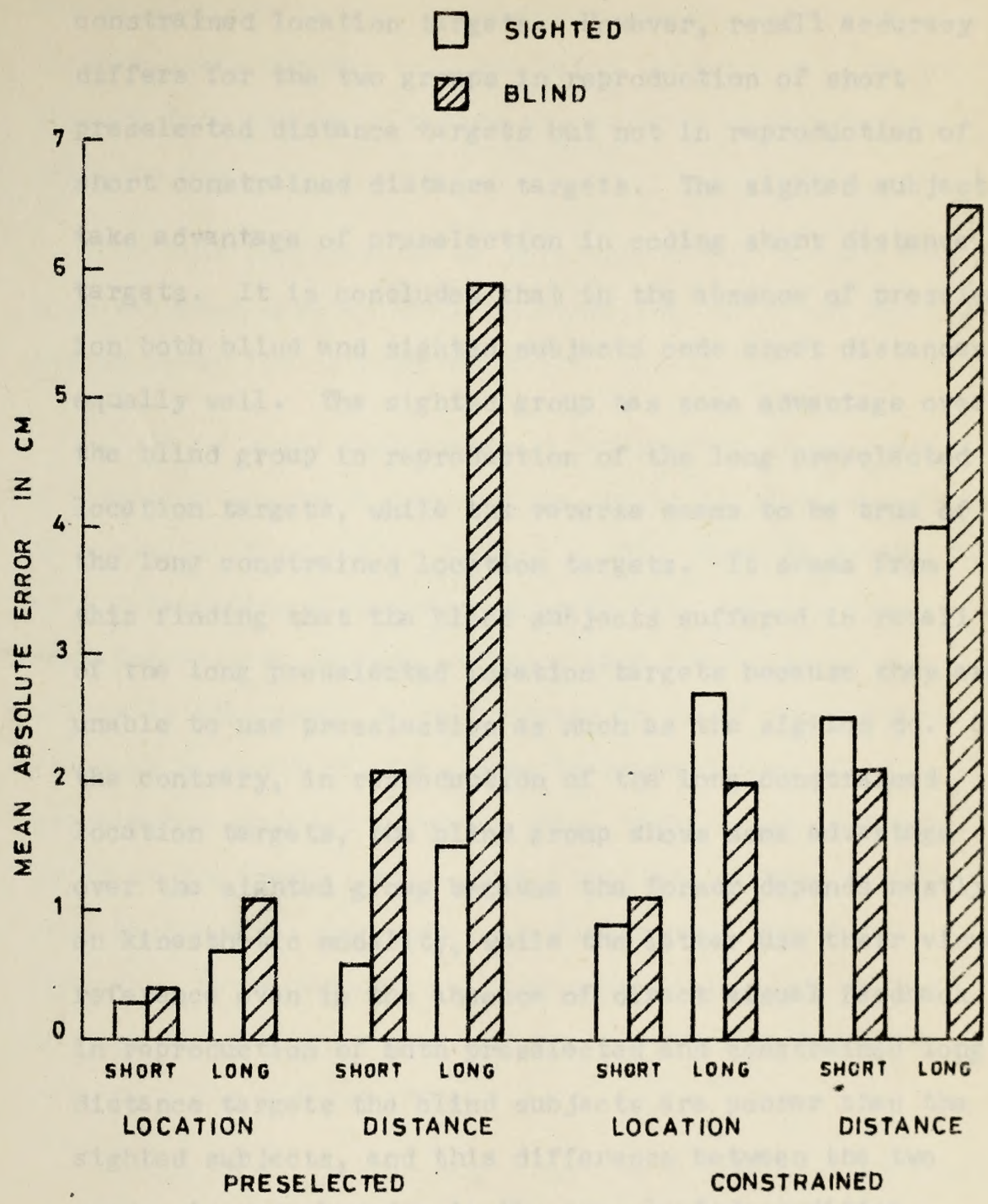


FIG.3.4.11 MEAN ABSOLUTE ERROR OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF SHORT/LONG LOCATIONS AND DISTANCES PRESENTED WITH AND WITHOUT PRESELECTION CUE

FIG.3A1) MEAN ABSOLUTE ERROR OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF SHORT/LONG LOCATIONS AND DISTANCES PRESENTED WITH AND WITHOUT PRESELECTION CUE

3.126 constrained location targets. However, recall accuracy differs for the two groups in reproduction of short preselected distance targets but not in reproduction of short constrained distance targets. The sighted subjects take advantage of preselection in coding short distance targets. It is concluded that in the absence of preselection both blind and sighted subjects code short distances equally well. The sighted group has some advantage over the blind group in reproduction of the long preselected location targets, while the reverse seems to be true of the long constrained location targets. It seems from this finding that the blind subjects suffered in recall of the long preselected location targets because they are unable to use preselection as much as the sighted do. On the contrary, in reproduction of the long constrained location targets, the blind group shows some advantage over the sighted group because the former depends mostly on kinesthetic modality, while the latter use their visual reference even in the absence of direct visual feedback. In reproduction of both preselected and constrained long distance targets the blind subjects are poorer than the sighted subjects, and this difference between the two groups is more broader in the preselected condition. Moreover, the sighted subjects perform better in reproduction of long preselected distance targets than in reproduction of the long constrained distance targets.

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3.127 The blind subjects show no such advantage. To sum up, these results suggest that the blind subjects fail to draw support from the preselection cue as much as the sighted subjects do.

Other implications of this interaction effect have been reported earlier while interpreting the first and the second order interaction effects.

It is noted that groups x informations x preselection x retention intervals interaction effect is significant in AE analysis: F (1,128) = 5.65, $p < .05$. Mean AE scores for this interaction effect are shown in Fig. 3.4.12. The most interesting finding emerging from this interaction effect is that there is no increase in AE of the sighted group as a result of time lapse in reproduction of preselected distance targets, while there is an increase in AE of the blind group. Both blind and sighted groups show increase in the error as a function of retention intervals in reproduction of constrained distance targets but the blind group shows loss in retention at a faster rate than the sighted group.

Groups x informations x targets x retention intervals interaction effect is significant for AE, F (1,128) = 38.77, $p < .01$; and CE, F (1,128) = 7.18, $p < .01$. Mean AE and CE for this interaction appear in Fig. 3.4.13. The main finding from this interaction effect is that the blind and

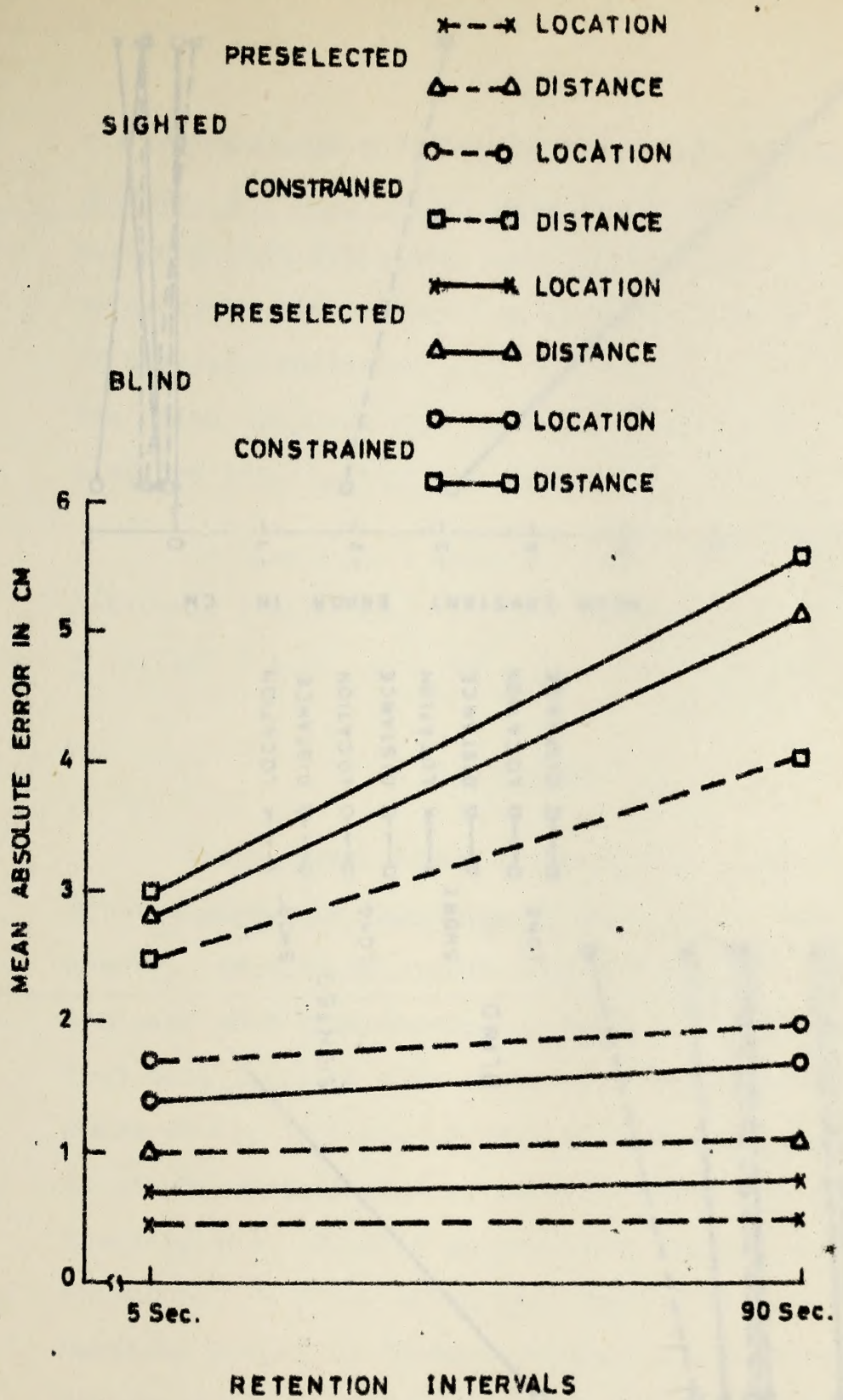


FIG.34.12 MEAN ABSOLUTE ERROR OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF PRESELECTED/ CONSTRAINED LOCATIONS AND DISTANCES OVER RETENTION INTERVALS OF 5- AND 90-Sec.

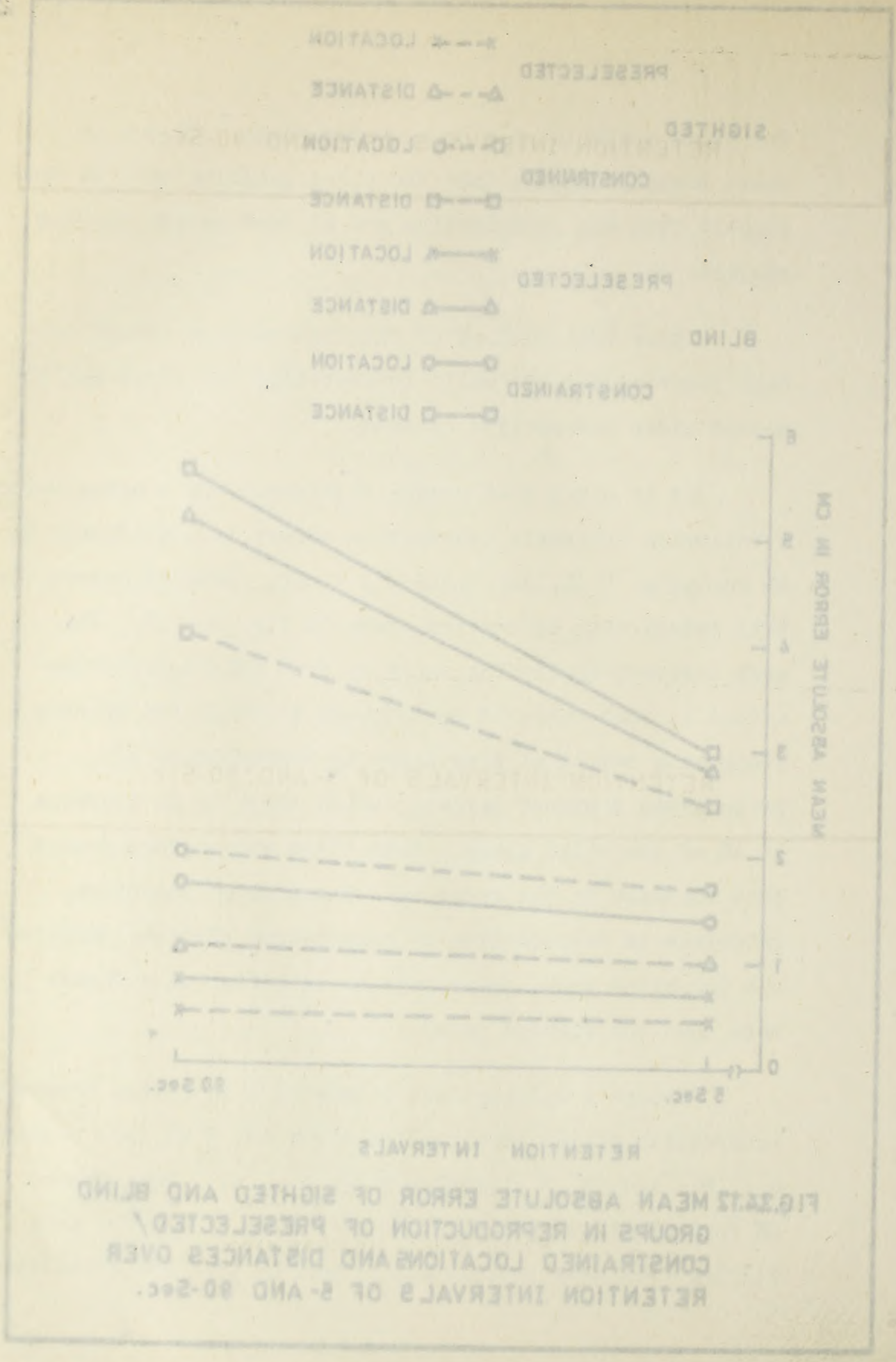


FIG. 3A.12 MEAN ABSOLUTE ERROR OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF PRESELECTED/ CONSTRAINED LOCATIONS AND DISTANCES OVER RETENTION INTERVALS OF 5- AND 90-Sec.

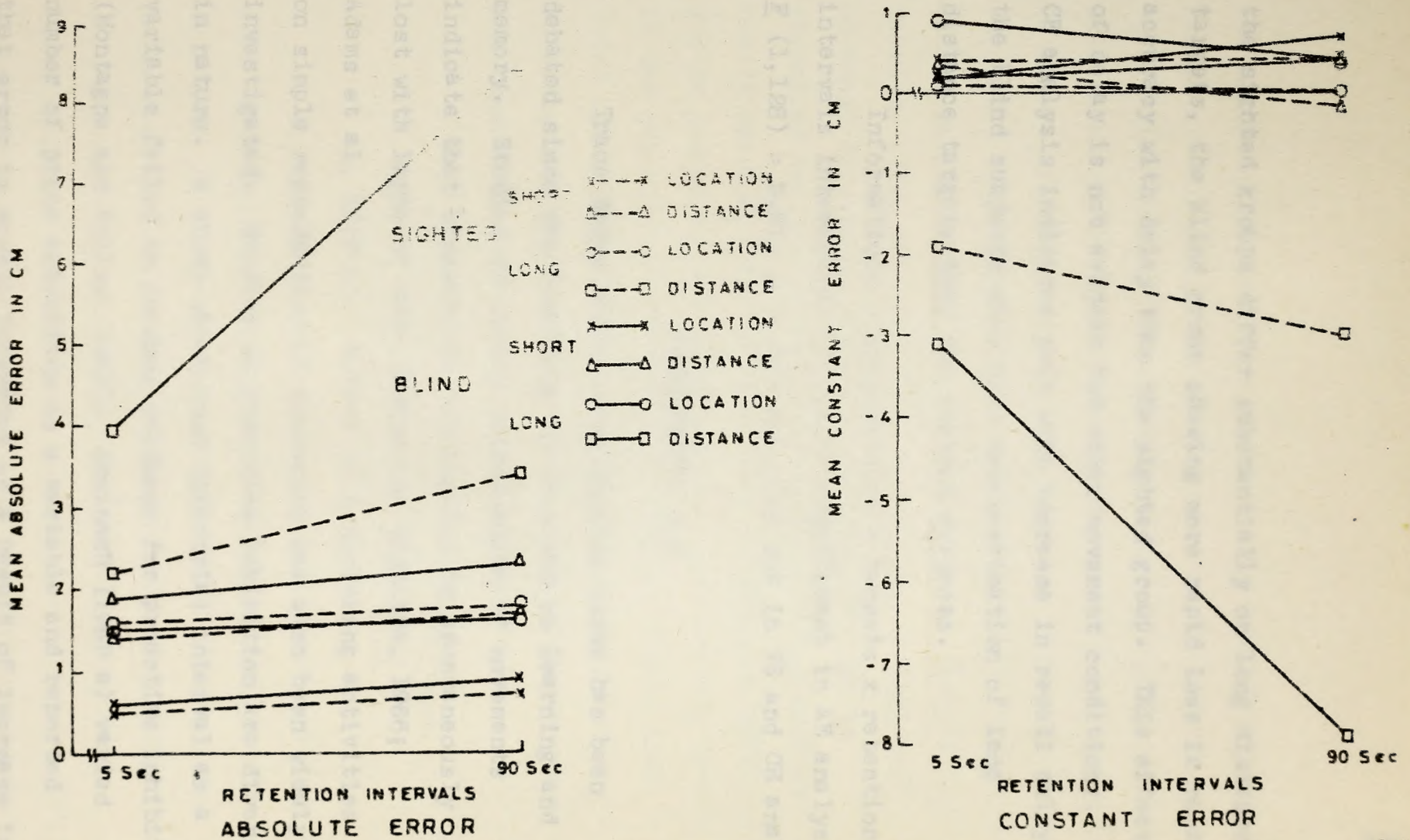


FIG. 3·4·13. MEAN ABSOLUTE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF SHORT / LONG LOCATION AND DISTANCES OVER 5 AND 90 SEC RETENTION INTERVALS.

FIG. 3.4.13 MEAN ABSOLUTE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN LOCATION AND DISTANCE JUDGMENTS OVER 5 AND 90 SEC RETENTION INTERVALS

3.128 the sighted groups differ substantially on long distance targets, the blind group showing more rapid loss in recall accuracy with delay than the sighted group. This effect of delay is not evident for other movement conditions. CE analysis indicates that with increase in recall delay the blind subjects show more underestimation of long distance targets than the sighted subjects.

Informations x preselection x targets x retention intervals interaction effect is significant in AE analysis, F (1,128) = 5.82, $p < .05$, only but not in VE and CE analyses.

EXPERIMENT 3.5

Trace decay versus interference issue has been debated since the beginning of research on learning and memory. Studies of simple reproduction of movements indicate that kinesthetic information is spontaneously lost with lapse of time (Adams and Dijkstra, 1966; Adams et al, 1972 a). Effect of interfering activities on simple reproduction of movements has also been widely investigated. Studies of proactive inhibition are diverse in nature. A study which used intertrial interval as a variable failed to produce evidence for proactive inhibition (Montagne and Hillix, 1968). Stelmach (1969 a) varied number of prior activities as a variable and reported that error in recall increases as a result of increase in

3.129 the number of prior activities but this result was not interpreted in terms of interference theory because information was lost even over unfilled delay intervals. Subsequently, Stelmach (1969 b) used prior activity varying in degree of similarity to the criterion response and supported his previous contention. Proactive Inhibition effect was also supported in other studies (Ascoli and Schmidt, 1969; Williams, 1971). Studies of isolated movement informations have shown that location is signalled by some motor kinesthetic mechanism such as muscle spindle information (Clark and Burgess, 1975) or muscle length/tension relationship (Bizzi et al, 1976). It was reported by Hermelin and O'Connor (1975) that blind and sighted children do not differ in immediate reproduction of location. Since kinesthetic receptors may signal location, it is proposed that :

> Prior motor activities would affect both blind and sighted subjects in reproduction of a location task.

On the other hand, there is sufficient evidence to show that distance information requires some perceptual reference system other than kinesthesis. It has been suggested that blind subjects are poorer than sighted subjects in reproduction of distance (Gregory, 1966; Hermelin and O'Connor, 1975; Salmoni and Sullivan, 1976). Results of the pilot study suggest that blind subjects

3.130 were poorer than sighted on short distances; but on long distances, sighted subjects were poorer than blind subjects. If coding of distance is supported by a nonmotor store like vision, it may be proposed that :

> Sighted subjects would be less affected by prior motor activities on a distance task than their blind counterparts.

In this experiment the hypotheses concerning location and distance are tested by manipulating two long and two short responses before the standard movement was given. It obviously means greater loss to the blind subjects because they tend to rely mainly on their kinesthetic sense. Even then it would be interesting to find out how they attenuate this interfering effect, and such a situation would probably focus more sharply on the coding mechanism of distance than that in which sighted subjects, though recall distance tasks blindfolded, are not altogether free from visual experience.

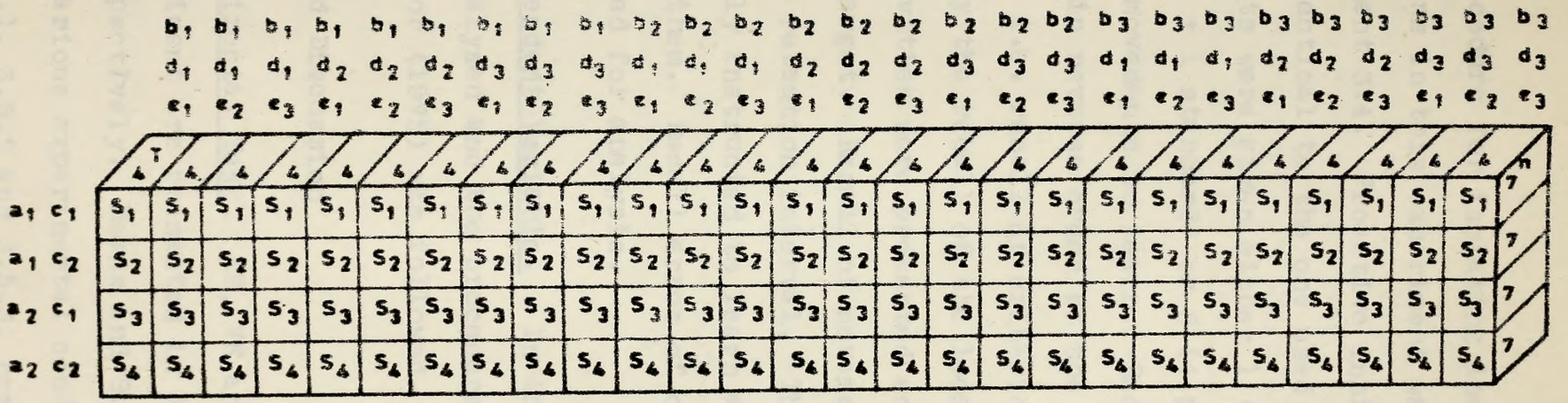
Method and Procedure

Sample. The sample of this experiment consisted of 42 sighted and 42 congenitally blind subjects. These subjects were equally divided on horizontal, vertical and curvilinear tasks. The blind subjects were selected from the hostels for the blind located in the city of Hyderabad in Andhra Pradesh and Gorakhpur in Uttar Pradesh. The

3.131 sighted subjects were also selected from the colleges of the same city. The sample of this experiment had similar characteristics, viz. age, education, intelligence, etc as those in the sample of the previous experiment.

Apparatus and Materials. The linear slide described in Experiment 3.4 was used for both horizontal and vertical tasks. For curvilinear movement a manual lever-D apparatus as reported in Experiment 3.1 was used. The other materials required were a opaque goggle and a stopwatch.

Experimental Design and Procedure. This experiment required a 2 x 2 x 3 x 3 x 3 (within subjects) factorial design consisting of groups (sighted or blind), informations (location or distance), retention intervals (0, 15 or 50 sec), targets (10, 20 or 30 cm/30°, 70° or 110°) and prior activities (0, 2 or 4) for each of the horizontal, vertical and curvilinear tasks. Arrangement of the subjects and experimental treatments are shown in Fig. 3.5.1. Four independent groups were formed for each of the three tasks, viz. sighted-location, sighted-distance, blind-location and blind-distance, and 7 subjects were randomly assigned to each of these groups. Twenty-seven experimental treatments were formed by combining retention intervals, targets and prior activities. Each of these 27 experimental treatments were presented to each subject on 4 trials. In all, 108 trials which were equally distributed into 4 sessions, were administered to each subject.



a - GROUP b - RETENTION INTERVAL c - INFORMATION d - TARGET e - N OF PRIOR ACTIVITY

1) SIGHTED	1) 00 Sec.	1) LOCATION	1) 10 cm	1) 0
2) BLIND	2) 15 Sec.	2) DISTANCE	2) 20 cm	2) 2
	3) 50 Sec.		3) 30 cm	3) 4

N = 28 (SIGHTED = 14 / BLIND = 14)

FIG. 3·5·1. DESIGN FOR EXPERIMENT 3·5

3.132 Procedure for isolating location and distance informations in this experiment was the same as described in Experiment 3.4. Proactive inhibition paradigm used here is identical to the one used by Stelmach (1969 a). The subjects were given either 1 (only standard), 3 (2 prior activities + 1 standard) or 5 (4 prior activities + 1 standard) movements to learn. Recall of these movements was taken in reverse order of the presentation of these movements, i.e. recall of criterion or standard was followed by the recall of the location of prior activities. Prior activities were presented equally on both sides on the standard target. Recall of movement was demanded at the end of the retention interval. The subjects were specifically instructed to learn all the movements and reproduce them. Recall error of only standard movement was recorded for analysis.

Dependent Variable. In this experiment AE, VE and CE were analysed and the procedure employed by Hermelin and O'Connor (1975) was followed.

Results and Discussion

Horizontal Task. AE, VE and CE scores obtained in this experiment are presented in Appendices 3.XII, 3.XIII, 3.XIV, respectively. Means and S.D. for AE, VE and CE data for various experimental conditions are presented in Tables 3.5.1, 3.5.2 and 3.5.3, respectively.

3.133 The main effects of different variables and their interactions have been examined in a 5-way ANOVA test (2 x 2 x 3 x 3 x 3) performed separately for AE, VE and CE data. The results of these tests are given in Tables 3.5.4, 3.5.5 and 3.5.6, respectively.

The ANOVA tests reveal that the main effect of groups is significant in AE analysis only: F (1,24) = 5.06, $p < .05$. The blind subjects (Mean = 3.64 cm) show more AE in recall of movement than the sighted subjects (Mean=3.29 cm). This finding supports the results obtained in the previous experiment that the blind subjects are poorer in movement reproduction than the sighted subjects.

All the three error analyses show significant effect of the informations: AE, F (1,24) = 146.11, $p < .01$; VE, F (1,24) = 34.69, $p < .01$; and CE, F (1,24) = 94.89, $p < .01$. Mean AE and VE for the location condition (AE = 2.52 cm; VE = 1.20 cm) are significantly less than the distance condition (AE = 4.41 cm; CE = 1.86 cm). This confirms results of our previous experiments that (1) location information is more precisely coded and is less variable than distance information, and (2) the subjects overestimate location targets (Mean CE = 0.65), but underestimate distance targets (Mean CE = -1.54).

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TABLE 3.5.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGET (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.27(0.05)	1.32(0.23)	1.51(0.41)	2.69(0.87)
		2	1.76(0.44)	1.51(0.38)	2.98(0.71)	2.95(0.67)
		4	3.14(0.31)	1.63(0.30)	3.98(0.80)	2.37(0.55)
	20	0	0.55(0.11)	1.96(0.29)	1.22(0.44)	1.80(0.73)
		2	2.31(0.27)	2.10(0.15)	2.70(0.73)	2.96(0.78)
		4	3.85(0.23)	2.09(0.23)	3.71(0.99)	2.88(0.96)
	30	0	1.46(0.27)	2.86(0.30)	1.19(0.22)	5.28(2.03)
		2	3.45(0.40)	3.03(0.34)	1.70(0.80)	6.14(1.98)
		4	5.54(0.34)	3.13(0.43)	1.76(0.50)	7.42(2.45)
15	10	0	0.21(0.11)	2.92(0.42)	1.54(0.40)	3.03(1.09)
		2	1.69(0.39)	3.21(0.24)	3.28(1.01)	3.31(0.53)
		4	2.98(0.35)	3.10(0.17)	4.65(1.04)	3.34(1.55)
	20	0	0.56(0.13)	3.82(0.41)	1.33(0.41)	2.57(1.63)
		2	2.33(0.23)	3.61(0.46)	2.63(0.35)	3.91(0.78)
		4	3.79(0.37)	3.60(0.26)	3.78(1.09)	2.68(0.94)
	30	0	1.35(0.29)	6.00(0.53)	1.03(0.41)	7.70(1.35)
		2	3.47(0.55)	5.43(0.47)	1.93(0.38)	7.61(2.10)
		4	5.41(0.48)	5.66(0.35)	2.13(0.49)	8.12(2.48)
50	10	0	0.24(0.06)	4.75(0.56)	2.19(0.45)	3.94(0.95)
		2	1.34(0.14)	4.70(0.28)	5.08(1.21)	4.74(1.55)
		4	3.09(0.31)	4.74(0.22)	4.60(1.04)	3.92(1.52)
	20	0	0.60(0.05)	5.39(0.65)	1.55(0.58)	3.16(1.09)
		2	2.35(0.15)	5.27(0.46)	2.92(0.54)	4.34(1.01)
		4	3.79(0.33)	5.36(0.63)	4.37(0.98)	3.68(0.90)
	30	0	1.57(0.26)	8.02(0.29)	1.28(0.43)	7.47(1.27)
		2	3.68(0.44)	7.96(0.52)	2.15(0.66)	9.99(1.26)
		4	5.36(0.49)	7.78(0.41)	2.19(0.76)	9.26(2.31)

TABLE 3.6.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AR SCORES (IN CM) OF SLING AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGET (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		SLING	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.87(0.06)	1.32(0.25)	1.81(0.41)	2.39(0.87)
		2	1.76(0.44)	1.81(0.36)	2.08(0.71)	2.98(0.67)
		4	3.14(0.31)	1.63(0.30)	3.98(0.80)	2.37(0.85)
	30	0	0.59(0.11)	1.98(0.29)	1.22(0.44)	1.80(0.73)
		2	2.31(0.27)	2.10(0.15)	2.70(0.75)	2.96(0.78)
		4	3.88(0.23)	2.09(0.23)	3.71(0.99)	2.88(0.96)
	50	0	1.46(0.27)	2.86(0.30)	1.19(0.22)	2.38(2.03)
		2	3.43(0.40)	3.03(0.34)	1.70(0.80)	3.14(1.96)
		4	5.84(0.34)	3.13(0.43)	1.76(0.80)	2.42(2.45)
15	10	0	0.21(0.11)	2.98(0.42)	1.84(0.40)	2.03(1.09)
		2	1.69(0.39)	3.21(0.24)	2.88(1.01)	3.81(0.83)
		4	2.98(0.38)	3.10(0.17)	4.65(1.04)	3.24(1.85)
	30	0	0.86(0.13)	3.82(0.41)	1.33(0.41)	2.87(1.83)
		2	2.34(0.28)	3.61(0.46)	2.65(0.56)	3.91(0.78)
		4	3.79(0.37)	3.60(0.36)	3.78(1.07)	2.58(0.84)
	50	0	1.36(0.29)	6.00(0.53)	1.03(0.41)	2.70(1.39)
		2	3.47(0.85)	5.63(0.47)	1.52(0.38)	2.51(2.10)
		4	5.41(0.48)	5.66(0.35)	2.13(0.65)	3.12(2.48)
30	10	0	0.94(0.06)	4.75(0.86)	2.19(0.48)	3.94(0.96)
		2	1.24(0.14)	4.70(0.28)	3.08(1.21)	4.74(1.55)
		4	3.09(0.31)	4.74(0.22)	4.60(1.05)	3.98(1.82)
	30	0	0.00(0.05)	5.36(0.65)	1.85(0.89)	3.16(1.09)
		2	2.35(0.15)	5.27(0.46)	2.92(0.84)	4.34(1.01)
		4	3.72(0.85)	5.38(0.68)	4.37(0.96)	3.88(0.90)
	50	0	1.87(0.25)	8.02(0.29)	1.28(0.49)	2.47(1.27)
		2	3.08(0.44)	7.36(0.52)	2.15(0.66)	3.90(1.36)
		4	5.30(0.49)	7.78(0.41)	3.19(0.96)	3.36(2.31)

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TABLE 3.5.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VARIOUS HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVALS (RI), TARGETS (T), AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.29(0.06)	0.88(0.59)	0.54(0.26)	0.91(0.35)
		2	0.94(0.60)	1.00(0.55)	0.67(0.48)	1.88(0.96)
		4	0.33(0.18)	0.57(0.46)	0.86(0.32)	1.22(0.55)
	20	0	0.50(0.11)	1.67(0.27)	0.91(0.33)	1.72(0.99)
		2	1.53(0.90)	1.47(0.87)	0.87(0.54)	1.81(1.08)
		4	3.11(1.19)	1.81(0.26)	0.70(0.31)	2.06(0.98)
	30	0	0.93(0.51)	1.20(1.12)	0.94(0.39)	1.42(0.56)
		2	2.51(1.47)	1.41(1.26)	1.31(0.96)	1.72(0.63)
		4	1.84(2.31)	1.60(1.16)	1.22(0.69)	2.03(0.53)
15	10	0	0.18(0.07)	1.25(1.14)	0.63(0.37)	1.49(0.62)
		2	0.63(0.54)	1.60(1.26)	0.83(0.45)	1.89(1.52)
		4	1.01(1.21)	2.07(1.13)	1.03(0.28)	1.79(0.89)
	20	0	0.54(0.16)	2.67(1.62)	1.03(0.41)	2.40(1.55)
		2	1.31(0.92)	2.36(1.24)	1.53(1.03)	1.68(0.92)
		4	3.16(1.22)	3.36(0.44)	1.79(1.65)	2.04(1.20)
	30	0	0.83(0.39)	1.92(1.78)	0.92(0.27)	1.79(1.07)
		2	1.99(1.52)	3.03(2.29)	1.16(0.80)	2.19(1.72)
		4	1.91(2.48)	2.69(2.66)	1.65(0.76)	1.98(0.64)
50	10	0	0.26(0.06)	3.22(2.02)	0.82(0.45)	1.52(0.78)
		2	0.55(0.40)	1.07(1.31)	0.99(0.46)	1.71(0.76)
		4	0.68(0.79)	1.04(1.21)	1.60(1.35)	1.85(0.99)
	20	0	0.65(0.08)	3.89(2.48)	0.54(0.30)	1.94(1.51)
		2	1.60(1.03)	3.83(2.22)	1.72(1.28)	1.45(1.43)
		4	1.72(1.77)	3.14(2.04)	3.45(1.34)	2.16(1.01)
	30	0	0.56(0.54)	0.73(0.24)	1.17(0.48)	2.23(1.28)
		2	1.74(1.69)	0.70(0.37)	1.54(0.89)	2.30(1.85)
		4	0.99(1.47)	0.69(0.37)	1.91(0.42)	2.49(1.43)

TABLE 3.5.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VARIOUS HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVALS (RI), TARGETS (T), AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.29(0.06)	0.88(0.59)	0.54(0.20)	0.91(0.35)
		2	0.94(0.60)	1.00(0.65)	0.67(0.48)	1.88(0.98)
		4	0.33(0.18)	0.87(0.46)	0.86(0.36)	1.86(0.85)
	20	0	0.50(0.11)	1.67(0.27)	0.91(0.33)	1.72(0.99)
		2	1.53(0.90)	1.47(0.87)	0.87(0.54)	1.81(1.08)
		4	3.11(1.10)	1.81(0.25)	0.70(0.31)	2.06(0.88)
	30	0	0.95(0.51)	1.20(1.12)	0.94(0.32)	1.46(0.86)
		2	2.31(1.47)	1.41(1.36)	1.31(0.96)	1.72(0.52)
		4	1.84(2.31)	1.60(1.16)	1.22(0.69)	2.03(0.53)
15	10	0	0.16(0.07)	1.25(1.14)	0.63(0.37)	1.46(0.62)
		2	0.63(0.34)	1.60(1.36)	0.83(0.45)	1.89(1.89)
		4	1.01(1.21)	2.07(1.13)	1.03(0.28)	1.79(0.89)
	20	0	0.94(0.16)	2.67(1.69)	1.03(0.41)	2.40(1.65)
		2	1.31(0.92)	2.36(1.24)	1.83(1.03)	1.88(0.92)
		4	3.16(1.28)	3.36(0.44)	1.79(1.65)	2.04(1.80)
	30	0	0.85(0.39)	1.92(1.78)	0.92(0.27)	1.76(1.07)
		2	1.99(1.52)	3.03(2.29)	1.16(0.80)	2.19(1.72)
		4	1.91(2.48)	2.69(2.66)	1.65(0.76)	1.08(0.84)
50	10	0	0.26(0.06)	3.22(2.02)	0.82(0.48)	1.82(0.78)
		2	0.55(0.40)	1.07(1.31)	0.99(0.46)	1.71(0.75)
		4	0.68(0.79)	1.04(1.21)	1.60(1.35)	1.86(0.89)
	20	0	0.65(0.08)	3.89(2.48)	0.54(0.30)	1.94(1.81)
		2	1.80(1.03)	3.83(2.22)	1.72(1.38)	1.45(1.43)
		4	1.78(1.77)	3.14(2.04)	3.45(1.36)	2.16(1.01)
	30	0	0.56(0.54)	0.73(0.84)	1.17(0.48)	2.23(1.28)
		2	1.74(1.69)	0.70(0.37)	1.54(0.89)	2.30(1.85)
		4	0.89(1.47)	0.66(0.37)	1.91(0.42)	2.42(1.43)

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TABLE 3.5.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER VARIOUS RETENTION INTERVALS (RI), TARGETS (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.07(0.10)	0.67(0.63)	1.51(0.41)	2.66(0.91)
		2	1.33(0.71)	0.92(0.72)	2.98(0.71)	2.45(1.10)
		4	3.14(0.31)	1.45(0.50)	3.98(0.80)	2.19(0.72)
	20	0	0.19(0.33)	0.38(1.04)	0.98(0.56)	-0.32(1.02)
		2	0.21(1.68)	0.24(1.40)	2.56(0.89)	-2.04(1.63)
		4	-1.04(1.87)	0.47(1.02)	3.71(0.99)	-1.65(2.04)
	30	0	-0.86(0.75)	-1.90(1.63)	-0.01(1.00)	-5.28(2.03)
		2	-0.86(1.97)	-2.42(0.73)	0.74(1.05)	-6.14(1.98)
		4	-4.34(2.23)	-2.36(1.03)	0.69(1.37)	-7.42(2.45)
15	10	0	0.16(0.15)	2.38(0.73)	1.43(0.56)	2.70(1.40)
		2	1.51(0.55)	2.33(1.34)	3.19(1.15)	2.70(0.94)
		4	2.54(0.71)	1.86(1.08)	4.65(1.04)	2.79(1.86)
	20	0	0.09(0.25)	0.20(2.52)	0.95(0.62)	-0.87(1.95)
		2	0.24(1.89)	0.18(2.80)	1.91(0.89)	-3.39(1.49)
		4	0.93(1.70)	-0.93(0.95)	3.08(1.12)	-0.89(1.74)
	30	0	-0.85(0.84)	-5.35(1.54)	-0.35(0.80)	-7.63(1.44)
		2	-2.13(1.54)	-3.68(1.89)	-1.10(1.20)	-7.34(2.34)
		4	-3.88(2.61)	-3.90(2.18)	-0.49(1.60)	-8.08(2.55)
50	10	0	0.09(0.10)	2.84(1.60)	2.19(0.45)	3.81(1.12)
		2	1.75(0.30)	4.40(0.77)	5.75(1.21)	4.63(1.71)
		4	2.87(0.78)	4.44(0.98)	4.28(1.53)	3.75(1.64)
	20	0	-0.03(0.27)	-2.41(2.02)	1.52(0.64)	-1.04(2.48)
		2	0.55(1.48)	1.25(3.07)	1.36(1.96)	-3.60(2.14)
		4	-2.39(1.95)	3.76(1.63)	2.55(1.47)	-2.32(2.44)
	30	0	-1.30(0.65)	-8.02(0.29)	-0.38(0.80)	-7.36(1.36)
		2	-2.60(1.43)	-7.96(0.52)	-1.51(0.72)	-9.85(1.32)
		4	-5.01(1.29)	-7.78(0.41)	-0.75(1.65)	-9.25(2.31)

TABLE 3.5.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF VR SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER VARIOUS RETENTION INTERVALS (RI), TARGETS (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (cm)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.07(0.10)	0.67(0.63)	1.51(0.41)	2.66(0.91)
		2	1.33(0.71)	0.92(0.72)	2.98(0.71)	2.45(1.10)
		4	3.14(0.31)	1.46(0.50)	3.98(0.80)	2.19(0.72)
	20	0	0.19(0.33)	0.38(1.04)	0.98(0.86)	-0.32(1.09)
		2	0.21(1.68)	0.24(1.40)	2.86(0.89)	-3.04(1.83)
		4	-1.04(1.87)	0.47(1.08)	3.71(0.99)	-1.86(2.04)
	30	0	-0.86(0.76)	-1.80(1.65)	-0.01(1.00)	-5.29(2.03)
		2	-0.86(1.97)	-2.42(0.73)	0.74(1.05)	-6.14(1.98)
		4	-4.34(2.23)	-2.36(1.05)	0.89(1.37)	-7.42(2.65)
15	10	0	0.16(0.15)	2.38(0.73)	1.43(0.56)	2.70(1.40)
		2	1.81(0.86)	2.33(1.34)	3.19(1.15)	2.70(0.94)
		4	2.84(0.71)	1.86(1.08)	4.65(1.04)	2.79(1.86)
	20	0	0.09(0.25)	0.80(2.52)	0.95(0.62)	-0.87(1.05)
		2	0.24(1.89)	0.18(2.80)	1.91(0.89)	-3.39(1.49)
		4	0.93(1.70)	-0.93(0.95)	3.08(1.12)	-0.82(1.74)
	30	0	-0.85(0.84)	-5.35(1.54)	-0.35(0.80)	-7.63(1.44)
		2	-2.13(1.54)	-3.58(1.89)	-1.10(1.50)	-7.34(2.34)
		4	-3.89(2.81)	-3.90(2.18)	-0.49(1.60)	-8.78(2.85)
30	10	0	0.09(0.10)	2.84(1.60)	2.19(0.45)	3.81(1.18)
		2	1.75(0.30)	4.40(0.77)	3.75(1.21)	4.65(1.71)
		4	2.87(0.76)	4.44(0.98)	4.38(1.53)	3.75(1.84)
	20	0	-0.03(0.27)	-2.41(2.02)	1.52(0.84)	-1.04(2.48)
		2	0.85(1.48)	1.25(3.07)	1.86(1.08)	-3.60(2.14)
		4	-2.39(1.95)	3.76(1.85)	2.88(1.47)	-2.32(2.34)
	30	0	-1.30(0.66)	-8.02(0.29)	-0.38(0.80)	-7.36(1.36)
		2	-3.80(1.42)	-7.96(0.52)	-1.81(0.78)	-8.86(1.32)
		4	-6.01(1.28)	-7.78(0.41)	-3.75(1.65)	-9.29(2.21)

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TABLE 3.5.4

SUMMARY OF ANOVA OBTAINED FOR AE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	823.43	27			
Groups (G)	23.46	1	23.46	5.06	.05
Informations (I)	676.84	1	676.84	146.11	.01
G x I	11.96	1	11.96	2.58	-
Subjects within groups	111.18	24	4.63		
Within subjects	2767.88	728			
Retention Intervals (RI)	306.08	2	153.04	173.66	.01
G x R	16.61	2	8.30	9.42	.01
I x R	193.35	2	96.68	109.70	.01
G x I x R	54.68	2	27.34	31.02	.01
R x subjects within groups	42.30	48	0.88		
Prior Activities (P)	300.81	2	150.41	193.96	.01
G x P	11.33	2	5.66	7.30	.01
I x P	175.02	2	87.51	112.85	.01
G x I x P	32.09	2	16.04	20.69	.01
P x subjects within groups	37.22	48	0.78		
Targets (T)	485.08	2	242.54	172.80	.01
G x T	35.02	2	17.57	12.47	.01
I x T	425.92	2	212.96	151.73	.01
G x I x T	272.86	2	136.43	97.20	.01

TABLE 5.6.4

SUMMARY OF ANOVA OBTAINED FOR AS SCORES OF HORIZONTAL TASK IN EXPERIMENT 5.6

Source	SS	df	MS	F	p
Between subjects	823.43	27			
Groups (G)	23.46	1	23.46	8.08	.05
Informations (I)	676.84	1	676.84	146.11	.01
G x I	11.95	1	11.95	2.58	-
Subjects within groups	111.18	24	4.63		
Within subjects	2767.88	728			
Retention Intervals (RI)	306.08	2	153.04	173.66	.01
G x R	16.81	2	8.30	9.42	.01
I x R	193.55	2	96.88	109.70	.01
G x I x R	54.68	2	27.34	31.02	.01
R x subjects within groups	42.30	48	0.88		
Prior Activities (P)	300.81	2	150.41	195.96	.01
G x P	11.33	2	5.66	7.30	.01
I x P	175.02	2	87.51	112.85	.01
G x I x P	32.09	2	16.04	20.69	.01
P x subjects within groups	37.52	48	0.78		
Targets (T)	485.08	2	242.54	172.80	.01
G x T	35.02	2	17.51	12.47	.01
I x T	485.92	2	242.96	181.73	.01
G x I x T	272.86	2	136.43	97.20	.01

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TABLE 3.5.4 (CONTD.)

Source	SS	df	MS	F	p
T x subjects within groups	67.37	48	1.40		
G x P	5.01	4	1.25	3.68	.01
G x R x P	3.50	4	0.87	2.57	.05
R x I x P	2.57	4	0.64	1.89	-
G x R x I x P	1.49	4	0.37	1.10	-
RP x subjects within groups	32.63	96	0.34		
R x T	13.94	4	3.49	6.31	.01
G x R x T	3.30	4	0.83	1.50	-
R x I x T	19.94	4	4.99	9.06	.01
G x R x I x T	0.24	4	0.06	0.11	-
RT x subjects within groups	53.04	96	0.55		
P x T	1.46	4	0.36	0.64	-
G x P x T	3.57	4	0.89	1.57	-
I x P x T	7.67	4	1.92	3.38	.05
G x I x P x T	33.37	4	8.34	14.73	.01
PT x subjects within groups	54.39	96	0.57		
R x P x T	5.84	8	0.73	2.51	.05
G x R x P x T	4.35	8	0.54	1.87	-
R x I x P x T	6.10	8	0.76	2.62	.01
G x R x I x P x T	3.84	8	0.48	1.65	-
RPT x subjects within groups	55.90	192	0.29		
Total	3591.31	755			

TABLE 3.5.4 (CONTD.)

Source	SS	df	MS	F	p
T x subjects within groups	67.37	48	1.40		
G x P	6.01	4	1.25	3.68	.01
G x R x P	3.50	4	0.87	2.57	.05
R x I x P	2.57	4	0.64	1.89	-
G x R x I x P	1.46	4	0.37	1.10	-
RP x subjects within groups	32.85	96	0.34		
R x T	13.94	4	3.49	8.31	.01
G x R x T	3.30	4	0.83	1.80	-
R x I x T	15.94	4	4.39	9.06	.01
G x R x I x T	0.24	4	0.06	0.11	-
RT x subjects within groups	85.04	96	0.55		
P x T	1.46	4	0.36	0.64	-
G x P x T	3.57	4	0.89	1.57	-
I x P x T	7.67	4	1.92	3.38	.05
G x I x P x T	33.37	4	8.34	14.73	.01
PT x subjects within groups	84.39	96	0.87		
R x P x T	6.84	8	0.73	2.31	.05
G x R x P x T	4.35	8	0.54	1.87	-
R x I x P x T	6.10	8	0.76	2.82	.01
G x R x I x P x T	3.84	8	0.48	1.65	-
RPT x subjects within groups	55.90	192	0.29		
Total	3861.31	755			

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TABLE 3.5.5

SUMMARY OF ANOVA OBTAINED FOR VE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	141.79	27			
Groups (G)	0.08	1	0.08	0.03	-
Information (I)	83.71	1	83.71	34.69	.01
G x I	0.10	1	0.10	0.04	-
Subjects within groups	57.91	24	2.41		
Within subjects	1148.06	728			
Retention Intervals (R)	22.13	2	11.07	8.59	.01
G x R	7.97	2	3.99	3.09	-
I x R	9.97	2	4.84	3.76	.05
G x I x R	17.24	2	8.62	6.69	.01
R x subjects within groups	61.87	48	1.29		
Prior activities (P)	33.47	2	16.74	10.77	.01
G x P	0.81	2	0.41	0.26	-
I x P	23.33	2	11.66	7.50	.01
G x I x P	5.74	2	2.87	1.84	-
P x subjects within groups	74.62	48	1.55		
Targets (T)	79.37	2	39.68	26.41	.01
G x T	19.75	2	9.87	6.57	.01
I x T	7.34	2	3.67	2.44	-
G x I x T	12.26	2	6.13	4.08	.05

TABLE 3.5.5

SUMMARY OF ANOVA OBTAINED FOR VS SCORES OF VERTICAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	141.79	27			
Groups (G)	0.08	1	0.08	0.03	-
Information (I)	83.71	1	83.71	34.89	.01
G x I	0.10	1	0.10	0.04	-
Subjects within groups	57.91	24	2.41		
Within subjects	1148.06	728			
Retention Intervals (R)	22.13	2	11.07	8.59	.01
G x R	7.97	2	3.99	3.09	-
I x R	9.97	2	4.84	3.76	.05
G x I x R	17.24	2	8.62	6.69	.01
R x subjects within groups	61.87	48	1.29		
Prior activities (P)	33.47	2	16.74	10.77	.01
G x P	0.81	2	0.41	0.26	-
I x P	23.33	2	11.66	7.50	.01
G x I x P	5.74	2	2.87	1.84	-
P x subjects within groups	74.62	48	1.55		
Targets (T)	79.37	2	39.68	86.41	.01
G x T	19.75	2	9.87	6.57	.01
I x T	7.34	2	3.67	2.44	-
G x I x T	12.26	2	6.13	4.08	.05

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TABLE 3.5.5 (CONTD.)

Source	SS	df	MS	F	p
T x subjects within groups	72.14	48	1.50		
R x P	5.28	4	1.32	1.31	-
G x R x P	20.25	4	5.06	5.01	.01
R x I x P	6.86	4	1.72	1.70	-
G x R x I x P	3.10	4	0.78	0.77	-
RP x subjects within groups	92.62	96	1.01		
R x T	14.41	4	3.60	3.01	.05
G x R x T	18.97	4	4.74	3.96	.01
R x I x T	4.67	4	1.17	0.98	-
G x R x I x T	22.85	4	5.71	4.77	.01
RT x subjects within groups	115.06	96	1.20		
P x T	16.57	4	4.14	2.97	.05
G x P x T	7.99	4	2.00	1.43	-
I x P x T	9.59	4	2.40	1.72	-
G x I x P x T	4.05	4	1.01	0.73	-
P x subjects within groups	133.76	96	1.39		
R x P x T	6.32	8	0.79	0.79	-
G x R x P x T	9.98	8	1.25	1.25	-
R x I x P x T	4.94	8	0.62	0.62	-
G x R x I x P x T	7.68	8	0.96	0.96	-
RPT x subjects within groups	191.07	192	1.00		
Total	1289.86	755			

TABLE 3.8.5 (CONTD.)

Source	SS	df	MS	F	p
T x subjects within groups	72.14	48	1.50		
R x P	5.28	4	1.32	1.31	-
G x R x P	20.25	4	5.06	5.01	.01
R x I x P	5.86	4	1.72	1.70	-
G x R x I x P	3.10	4	0.78	0.77	-
RP x subjects within groups	92.62	96	1.01		
R x T	14.41	4	3.60	3.02	.05
G x R x T	18.37	4	4.74	3.98	.01
R x I x T	4.67	4	1.17	0.98	-
G x R x I x T	22.86	4	5.71	4.77	.01
RT x subjects within groups	115.06	96	1.20		
P x T	16.57	4	4.14	2.87	.05
G x P x T	7.29	4	2.00	1.43	-
I x P x T	9.59	4	2.40	1.72	-
G x I x P x T	4.05	4	1.01	0.73	-
P x subjects within groups	133.76	96	1.39		
R x P x T	6.32	8	0.79	0.79	-
G x R x P x T	9.98	8	1.25	1.25	-
R x I x P x T	4.54	8	0.57	0.57	-
G x R x I x P x T	7.68	8	0.96	0.96	-
RPT x subjects within groups	191.07	192	1.00		
Total	1289.86	755			

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TABLE 3.5.6

SUMMARY OF ANOVA OBTAINED FOR CE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	1640.18	27			
Groups (G)	37.32	1	37.32	3.90	-
Informations (I)	907.90	1	907.90	94.89	.01
G x I	465.34	1	465.34	48.64	.01
Subjects within groups	229.62	24	9.57		
Within subjects	8559.91	728			
Retention Intervals (R)	70.28	2	35.14	21.31	.01
G x R	21.55	2	10.78	6.54	.01
I x R	17.63	2	8.81	5.35	.01
G x I x R	5.72	2	2.86	1.73	-
R x subjects within groups	79.13	48	1.65		
Prior activities (P)	5.00	2	2.50	0.74	-
G x P	43.51	2	21.76	6.41	.01
I x P	27.62	2	13.81	4.07	.05
G x I x P	76.66	2	38.33	11.30	.01
P x subjects within groups	162.86	48	3.39		
Targets(T)	5120.25	2	2560.12	589.46	.01
G x T	79.29	2	39.64	9.13	.01
I x T	841.10	2	420.55	96.83	.01
G x I x T	116.99	2	58.50	13.47	.01
T x subjects within groups	208.47	48	4.34		

TABLE 3.6.6

SUMMARY OF ANOVA OBTAINED FOR CE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	1640.18	27			
Groups (G)	37.32	1	37.32	3.90	-
Informations (I)	907.90	1	907.90	94.89	.01
G x I	465.34	1	465.34	48.64	.01
Subjects within groups	229.62	24	9.57		
Within subjects	8889.91	728			
Retention Intervals (R)	70.28	2	35.14	21.31	.01
G x R	21.55	2	10.78	6.54	.01
I x R	17.63	2	8.81	5.35	.01
G x I x R	5.72	2	2.86	1.73	-
R x subjects within groups	79.13	48	1.65		
Prior activities (P)	5.00	2	2.50	0.74	-
G x P	43.51	2	21.76	6.41	.01
I x P	27.62	2	13.81	4.07	.05
G x I x P	76.66	2	38.33	11.30	.01
P x subjects within groups	162.86	48	3.39		
Targets(T)	5120.25	2	2560.12	889.46	.01
G x T	79.29	2	39.64	0.13	.01
I x T	841.10	2	420.55	96.83	.01
G x I x T	116.99	2	58.50	13.47	.01
T x subjects within groups	208.47	48	4.34		

.142

TABLE 3.5.6 (CONTD.)

Source	SS	df	MS	F	p
R x P	16.79	4	4.20	3.66	.01
G x R x P	15.59	4	3.90	3.39	.05
R x I x P	9.62	4	2.40	2.09	-
G x R x I x P	14.83	4	3.71	3.23	.05
RP x subjects within groups	110.25	96	1.15		
R x T	356.10	4	89.02	55.94	.01
G x R x T	15.12	4	3.78	2.38	-
R x I x T	119.05	4	29.76	18.72	.01
G x R x I x T	46.00	4	11.50	7.23	.01
RT x subjects within groups	152.79	96	1.59		
P x T	142.99	4	35.75	26.05	.01
G x P x T	62.15	4	15.54	11.32	.01
I x P x T	70.79	4	17.70	12.90	.01
G x I x P x T	48.56	4	12.14	8.85	.01
PT x subjects within groups	131.72	96	1.37		
R x P x T	47.25	8	5.91	4.40	.01
G x R x P x T	34.12	8	4.27	3.17	.01
R x I x P x T	23.25	8	2.91	2.16	.05
G x R x I x P x T	8.80	8	1.10	0.82	-
RPT x subjects within groups	258.05	192	1.34		
Total	10200.09	755			

TABLE 3.5.c (CONTD.)

Source	SS	df	MS	F	P
R x P	16.79	4	4.20	3.66	.01
G x R x P	13.59	4	3.90	3.39	.05
R x I x P	9.69	4	2.40	2.09	-
G x R x I x P	14.83	4	3.71	3.23	.05
RP x subjects within groups	110.25	96	1.15		
R x T	356.10	4	89.02	55.84	.01
G x R x T	15.12	4	3.78	2.38	-
R x I x T	119.05	4	29.76	18.72	.01
G x R x I x T	46.00	4	11.50	7.23	.01
RT x subjects within groups	152.79	96	1.59		
P x T	142.99	4	35.75	26.05	.01
G x P x T	62.15	4	15.54	11.32	.01
I x P x T	70.79	4	17.70	12.90	.01
G x I x P x T	48.56	4	12.14	8.85	.01
PT x subjects within groups	131.72	96	1.37		
R x P x T	47.25	8	5.91	4.40	.01
G x R x P x T	34.12	8	4.27	3.17	.01
R x I x P x T	23.28	8	2.91	2.16	.05
G x R x I x P x T	8.80	8	1.10	0.82	-
RPT x subjects within groups	256.08	192	1.34		
Total	10200.09	758			

3.143 The effect of retention intervals is significant for AE, $\underline{F}$ (2,48) = 173.66, $p < .01$; VE, $\underline{F}$(2,48) = 8.59, $p < .01$; and CE, $\underline{F}$ (2,48) = 21.31, $p < .01$. The mean AE scores for 0, 15 and 50 sec retention interval conditions are 2.70 cm, 3.43 cm and 4.26 cm, respectively. Mean VE scores for the 0, 15 and 50 sec retention interval conditions are 1.29 cm, 1.68 cm and 1.62 cm, respectively. Mean CE scores for the 0, 15, and 50 sec retention interval conditions are -0.09 cm, -0.42 cm and -0.83 cm, respectively. The results of AE and VE analyses indicate that errors increase with the increase in retention intervals, though VE data do not show change after 15 sec. The CE data suggest that underestimation of movement increases with the increase in length of retention intervals. These results are consistent with the results of the previous experiment and also with the findings of other studies (Adams and Dijkstra, 1966; Adams et al, 1972 a; Adams et al, 1972 b; Stelmach 1969 a, 1979 b).

Recall accuracy is found to be a function of the length of targets. This tendency is indicated in all the three error analyses: AE, $\underline{F}$ (2,48) = 172.8, $p < .01$; VE, $\underline{F}$ (2,48) = 26.41, $p < .01$, and CE, $\underline{F}$ (2,48) = 589.46, $p < .01$. For the 10, 20 and 30 cm targets, mean AE scores are 2.87 cm, 2.93 cm, and 4.60 cm, respectively; Mean VE scores are 1.11 cm, 1.89 cm, and 1.59 cm, respectively; and mean CE scores are 2.55 cm, -0.99 cm, and -3.80 cm, respectively.

3.144 AE data support the contention that errors increase with increase in target length. Both 20 and 30 cm targets show more variability in responses than 10 cm targets but responses at 20 cm middle target are more variable than the other two targets. CE data perfectly exhibits central tendency effect or range effect much in the same way as described in Experiment 3.4.

The main effect of prior activities is also significant for AE, $\underline{F}$ (2,48) = 193.96, $p < .01$; and VE, $\underline{F}$ (2,48) = 10.77, $p < .01$. For the 0, 2 and 4 prior activity conditions, mean AE scores are 2.62 cm, 3.64 cm, and 4.13 cm, respectively; and mean VE scores are 1.25 cm, 1.57 cm, and 1.76 cm, respectively. Both AE and VE data support the contention that reproduction error is a function of prior activities, i.e. errors increase with increase in number of prior activities.

Groups x informations interaction effect fails to reach a conventional level of statistical significance in AE and VE analyses but it is found significant in CE analysis, $\underline{F}$ (1,24) = 48.64, $p < .01$. Mean CE scores for this interaction effect appear in Fig. 3.5.2. The sighted group shows underestimation of location targets, while the blind group shows overestimation. The blind subjects tend to underestimate more than the sighted subjects in reproduction of distance targets. These observations about CE are

AE data support the contention that errors increase with increase in target length. Both 20 and 30 cm targets show more variability in responses than 10 cm targets but responses at 20 cm middle target are more variable than the other two targets. CE data perfectly exhibits central tendency effect or range effect must in the same way as described in Experiment 3.4.

The main effect of prior activities is also significant for AE, F (8,48) = 189.96, $p < .01$; and VE, F (8,48) = 10.47, $p < .01$. For the 0, 2 and 4 prior activity conditions, mean AE scores are 8.82 cm, 8.64 cm, and 4.15 cm, respectively; and mean VE scores are 1.28 cm, 1.57 cm, and 1.72 cm, respectively. Both AE and VE data support the contention that reproduction error is a function of prior activities, i.e. errors increase with increase in number of prior activities.

Groups x Informations interaction effect fails to reach a conventional level of statistical significance in AE and VE analyses but it is found significant in CE analysis, F (1,24) = 48.64, $p < .01$. Mean CE scores for this interaction effect appear in Fig. 5.3.2. The sighted group shows underestimation of location targets, while the blind group shows overestimation. The blind subjects tend to underestimate more than the sighted subjects in reproduction of distance targets. These observations about CE are

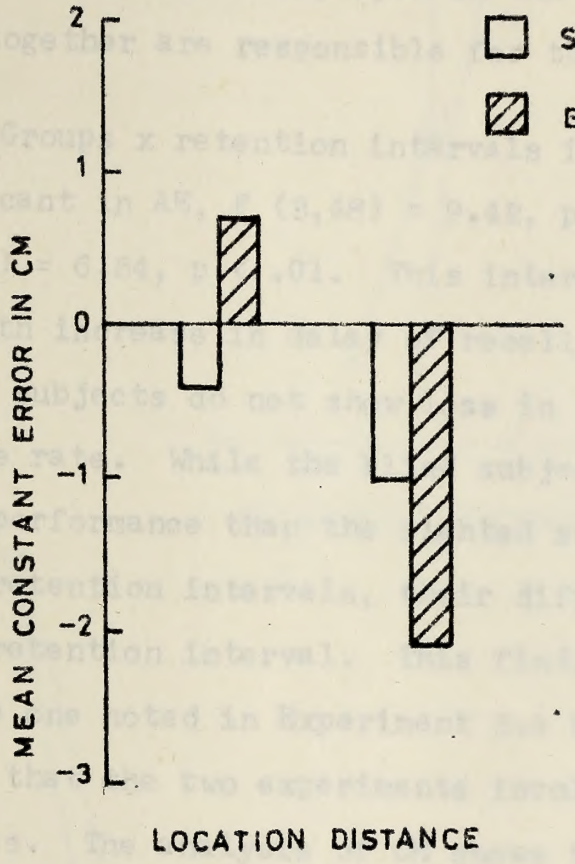


FIG.3.5.2 MEAN CONSTANT ERROR OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES

FIG.3.3.2 MEAN CONSTANT ERROR OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES

3.145 consistent with the results reported in Experiment 3.4. However, the AE and VE findings are not similar to results obtained in Experiment 3.4 because there are differences in the cues and targets employed in the two experiments, and these together are responsible for this difference.

Groups x retention intervals interaction is significant in AE, F (2,48) = 9.42, $p < .01$; and CE, F (2,48) = 6.54, $p < .01$. This interaction indicates that with increase in delay of recall, the blind and sighted subjects do not show loss in their retention at the same rate. While the blind subjects exhibit poorer performance than the sighted subjects at the 0 and 15 sec retention intervals, their differences disappear at the 50 sec retention interval. This finding does not resemble with the one noted in Experiment 3.4 but it should be borne in mind that the two experiments involve different experimental variables. The analysis of CE shows that the sighted group tends to underestimate with increase in the length of retention intervals, while the blind group overestimates in the immediate reproduction condition and underestimate at the 15 and 50 sec conditions with almost no difference between 15 and 50 sec conditions. This result suggests that the blind and sighted groups differ in their pattern of responses. The results are shown in Fig. 3.5.3.

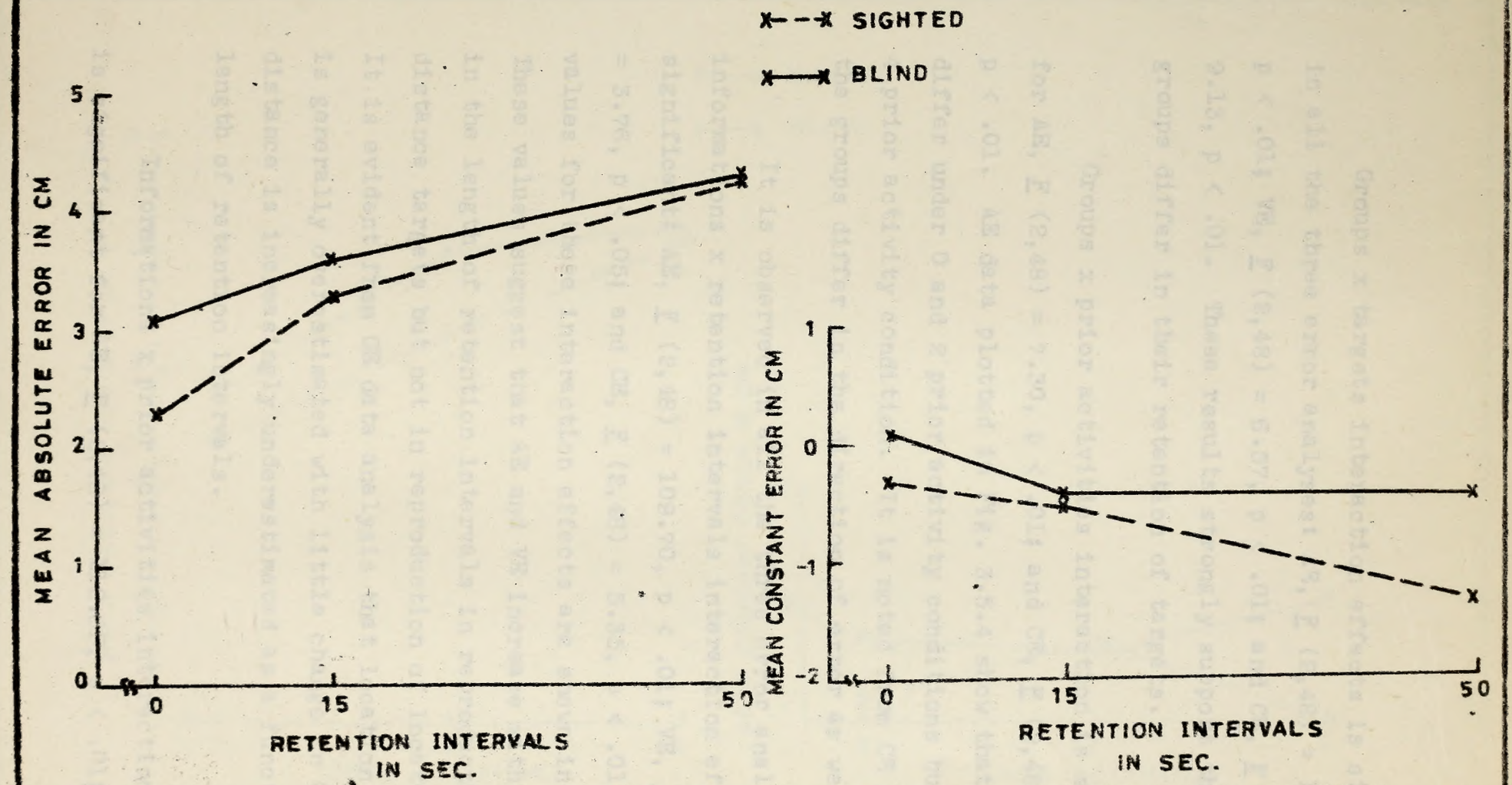
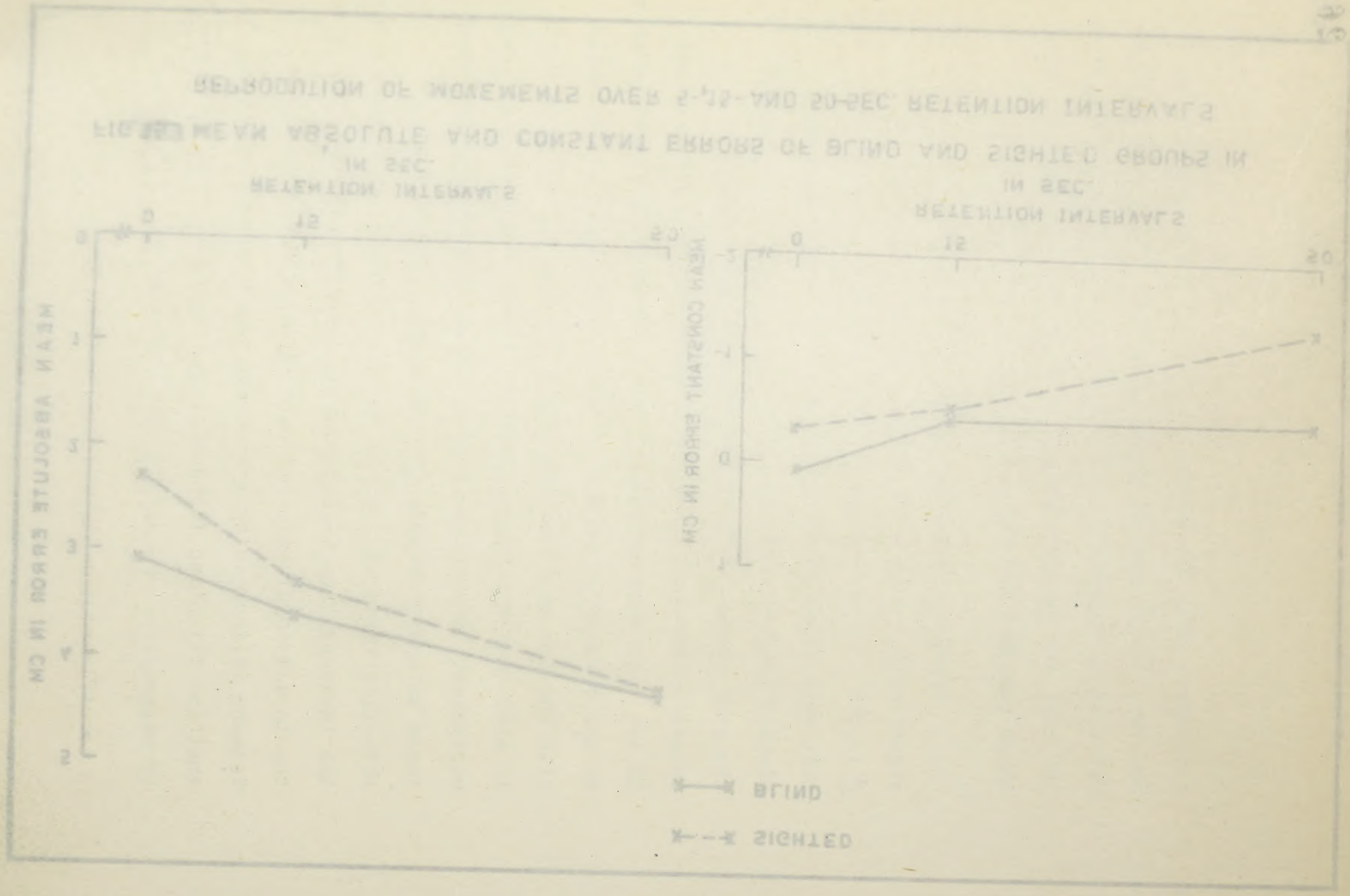


FIG. 353 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUTION OF MOVEMENTS OVER 5-, 15- AND 50-SEC. RETENTION INTERVALS


IN SEC.
RETENTION INTERVALS
0
15
30
MEAN ABSOLUTE ERROR IN CM
1
2
3
4
5
MEAN CONSTANT ERROR IN CM
-2
-1
0
1
BLIND
SIGHTED

3.146 Groups x targets interaction effects is significant in all the three error analyses: AE, $\underline{F}$ (2,48) = 12.47, $p < .01$; VE, $\underline{F}$ (2,48) = 6.57, $p < .01$; and CE, $\underline{F}$ (2,48) = 9.13, $p < .01$. These results strongly support that the two groups differ in their retention of targets.

Groups x prior activities interaction is significant for AE, $\underline{F}$ (2,48) = 7.30, $p < .01$; and CE, $\underline{F}$ (2,48) = 6.41, $p < .01$. AE data plotted in Fig. 3.5.4 show that groups differ under 0 and 2 prior activity conditions but not under 4 prior activity condition. It is noted from CE data that the groups differ in the direction of error as well.

It is observed in all the three error analyses that informations x retention intervals interaction effects are significant: AE, $\underline{F}$ (2,48) = 109.70, $p < .01$; VE, $\underline{F}$ (2,48) = 3.76, $p < .05$; and CE, $\underline{F}$ (2,48) = 5.35, $p < .01$. Mean values for these interaction effects are shown in Fig.3.5.5. These values suggest that AE and VE increase with increase in the length of retention intervals in reproduction of distance targets but not in reproduction of location targets. It is evident from CE data analysis that location information is generally overestimated with little change in CE, while distance is increasingly underestimated as a function of length of retention intervals.

Informations x prior activities interactions effect is significant for AE, $\underline{F}$ (2,48) = 112.85, $p < .01$; VE,

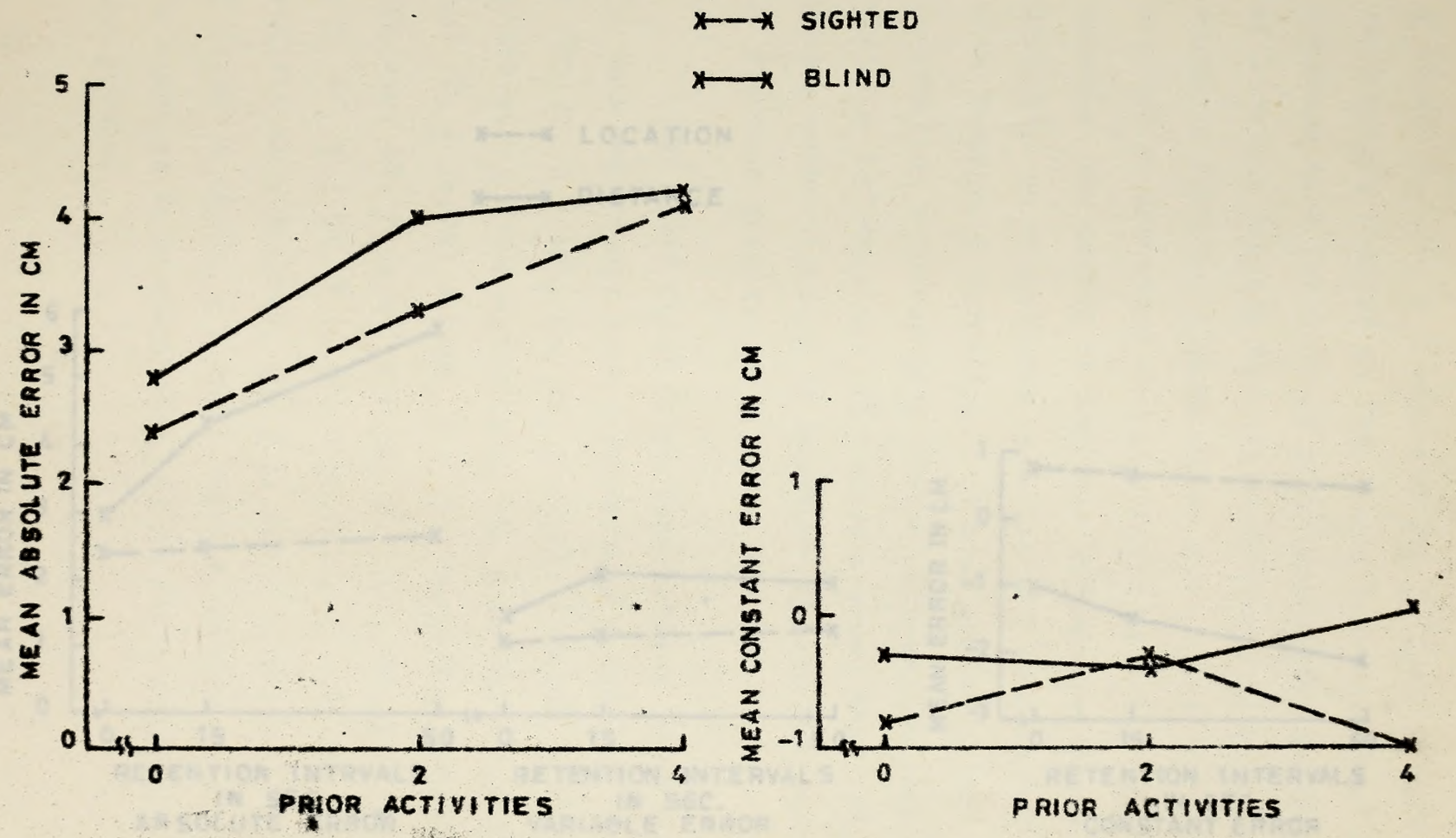
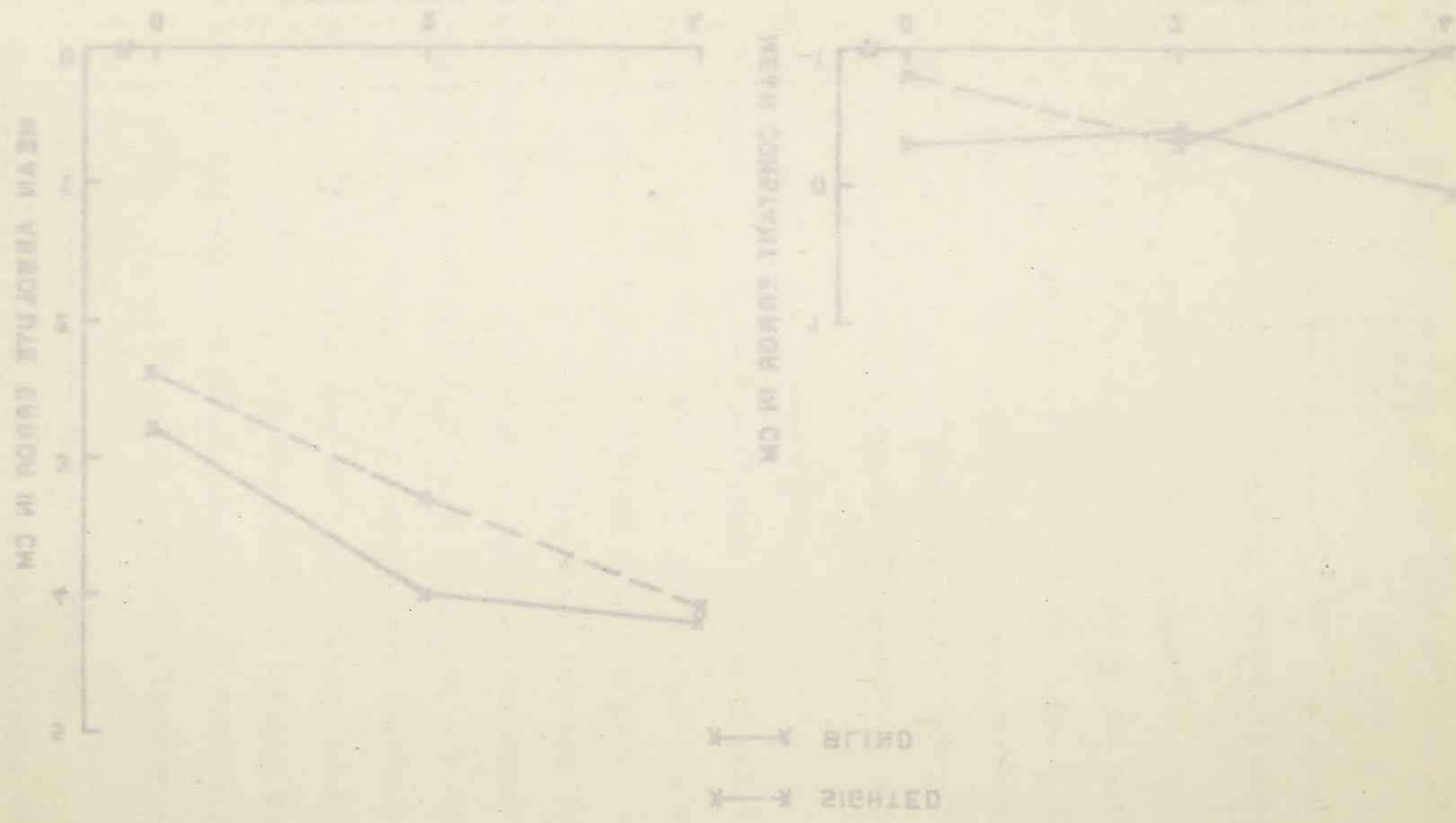


FIG.354 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS AS A FUNCTION OF PRIOR ACTIVITIES IN REPRODUCTION OF MOVEMENTS


BLIND
SIGHTED

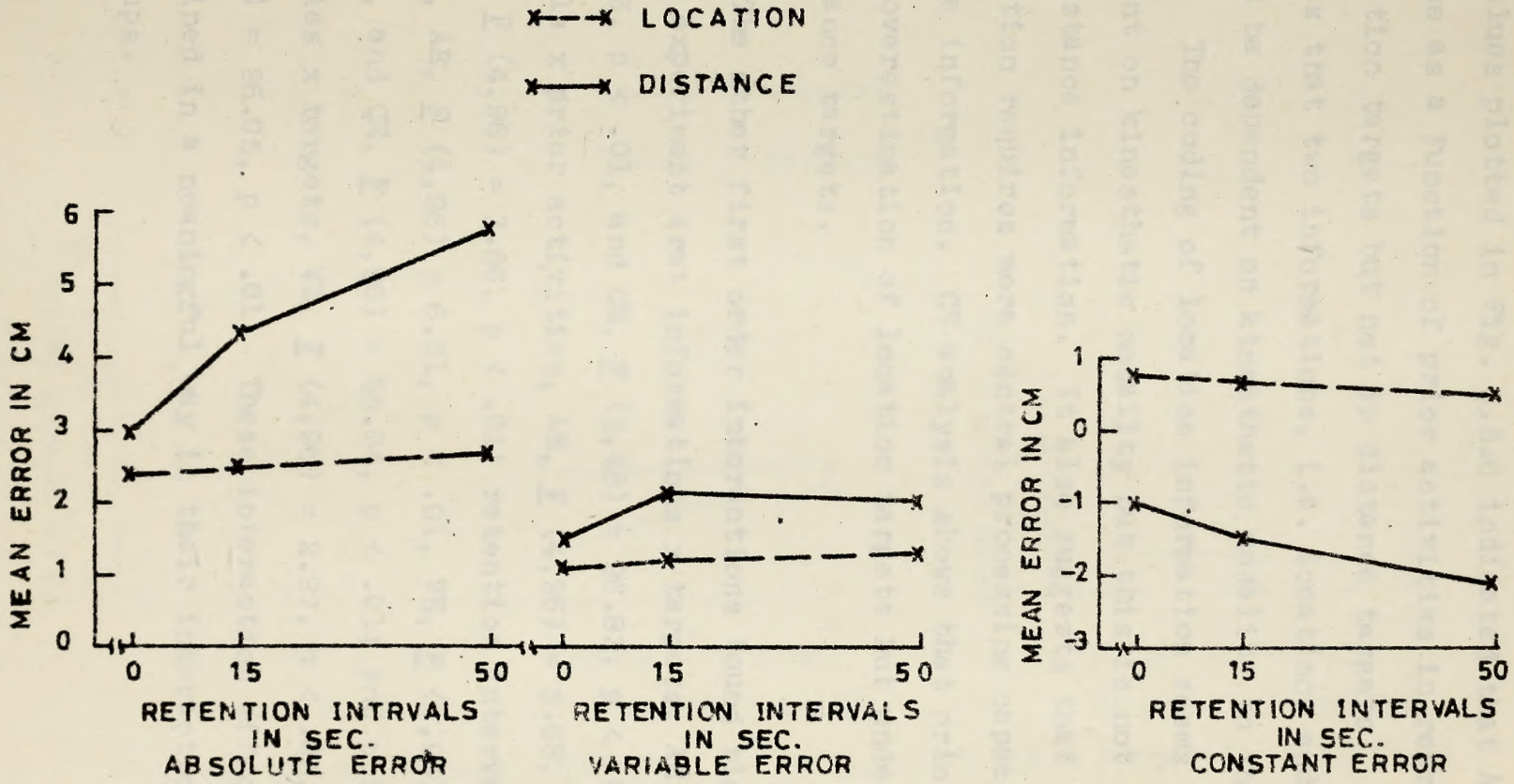
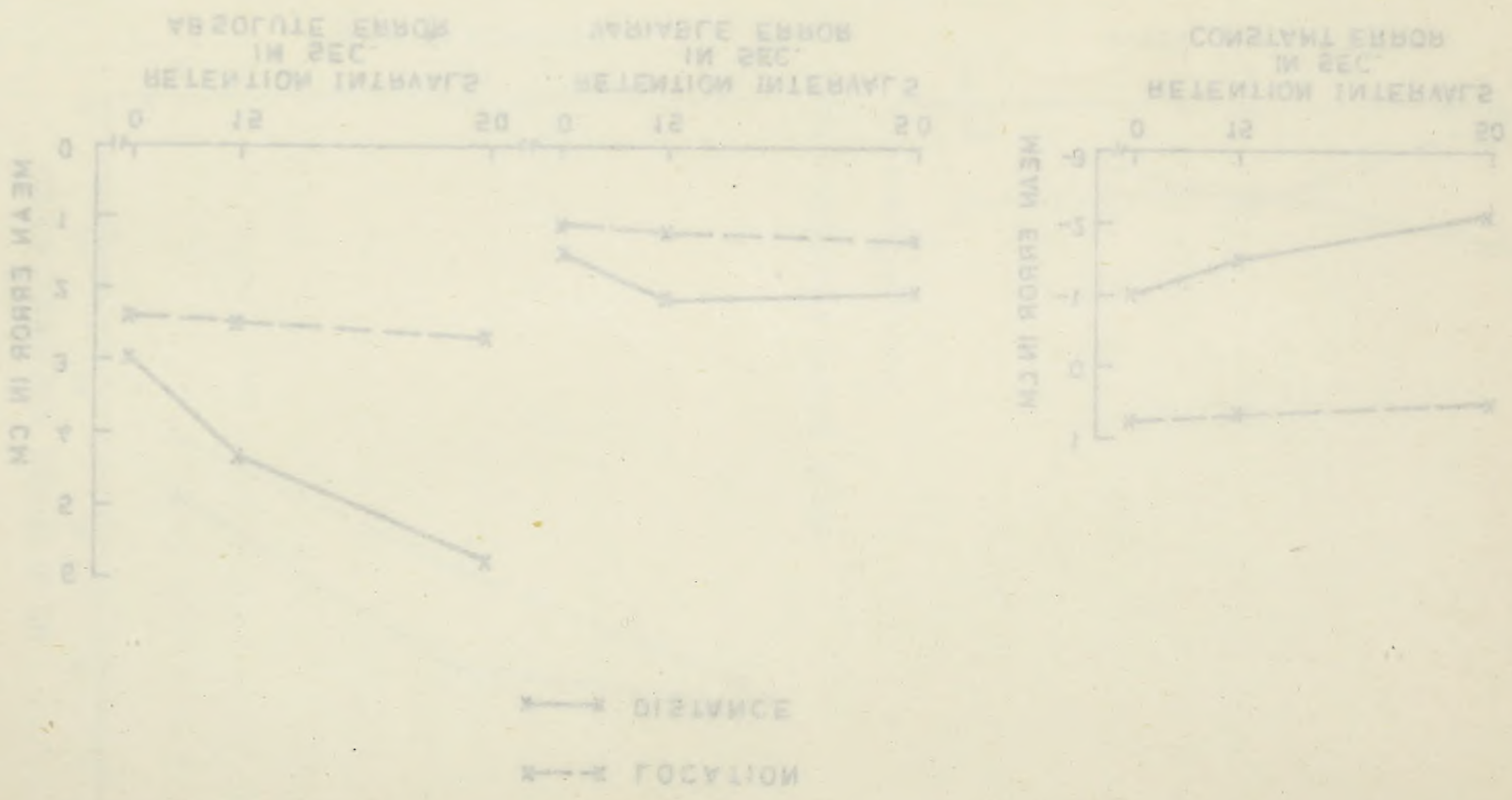


FIG.3.5.5 MEAN RECALL ERRORS OF SUBJECTS AS A FUNCTION OF RETENTION INTERVALS IN RECALL OF LOCATIONS AND DISTANCES


ABSOLUTE ERROR
IN SEC.
RETENTION INTERVALS
0
15
30
MEAN ERROR IN CM
0
1
2
3
4
5
6
VARIABLE ERROR
IN SEC.
RETENTION INTERVALS
0
15
30
CONSTANT ERROR
IN SEC.
RETENTION INTERVALS
0
15
30
MEAN ERROR IN CM
-3
-2
-1
0
1
DISTANCE
LOCATION

3.147 F (2,48) = 7.50, $p < .01$; and CE, F (2,48) = 4.07, $p < .01$. Mean values plotted in Fig. 3.5.6 indicated that AE and VE increase as a function of prior activities in reproduction of location targets but not in distance targets. It suggests that two informations, i.e. locations and distance, may not be dependent on kinesthetic modality to the same extent. The coding of location information seems to be dependent on kinesthetic modality but this is not the case with distance information. It also suggests that location information requires more central processing capacity than distance information. CE analysis shows that prior activity causes overestimation of location targets but underestimation of distance targets.

The other first order interactions found significant in this experiment are: informations x targets, AE, F (2,48) = 151.73, $p < .01$, and CE, F (2,48) = 96.83, $p < .01$; retention intervals x prior activities, AE, F (4,96) = 3.68, $p < .01$, and CE, F (4,96) = 3.66, $p < .01$; retention intervals x targets, AE, F (4,96) = 6.31, $p < .01$, VE, F (4,96) = 3.01, $p < .05$, and CE, F (4,96) = 55.94, $p < .01$; and prior activities x targets, VE, F (4,96) = 2.97, $p < .05$, and CE, F (4,96) = 26.05, $p < .01$. These interaction effects would be examined in a meaningful way in their interaction with the groups.

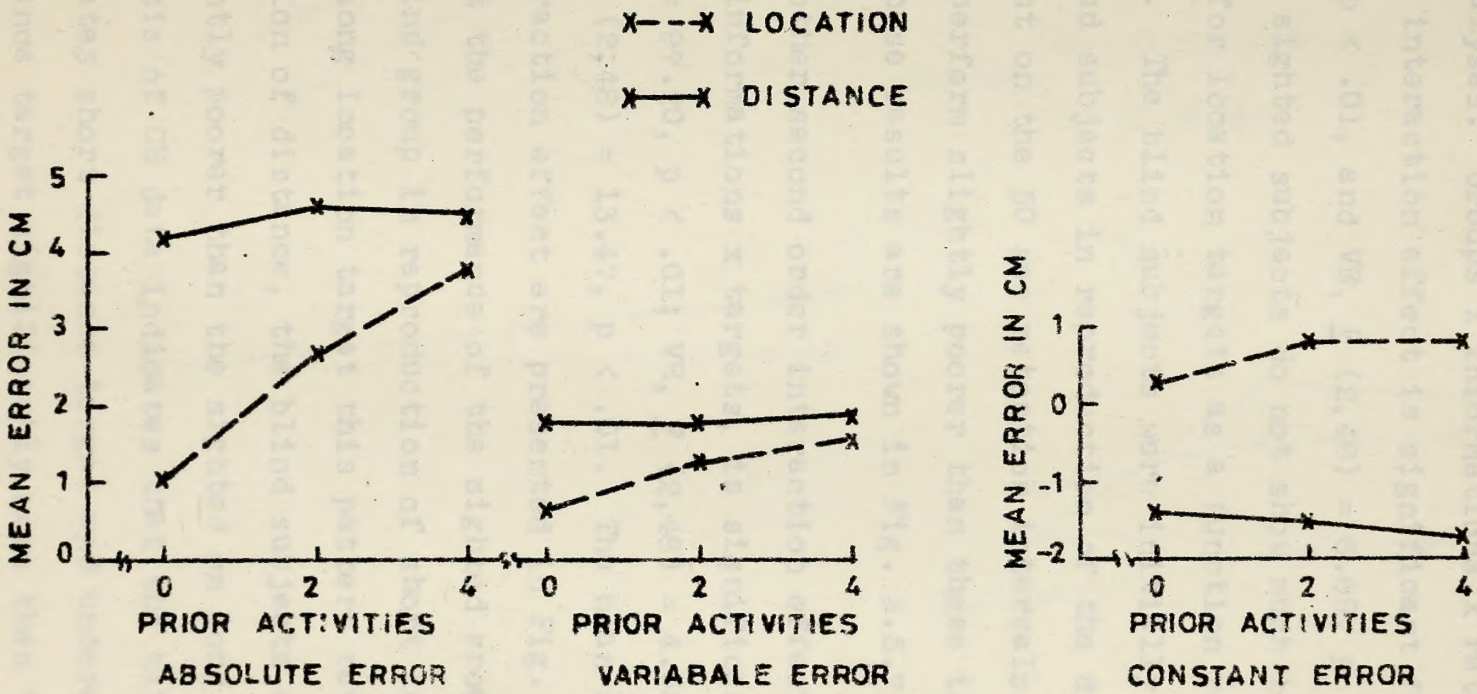
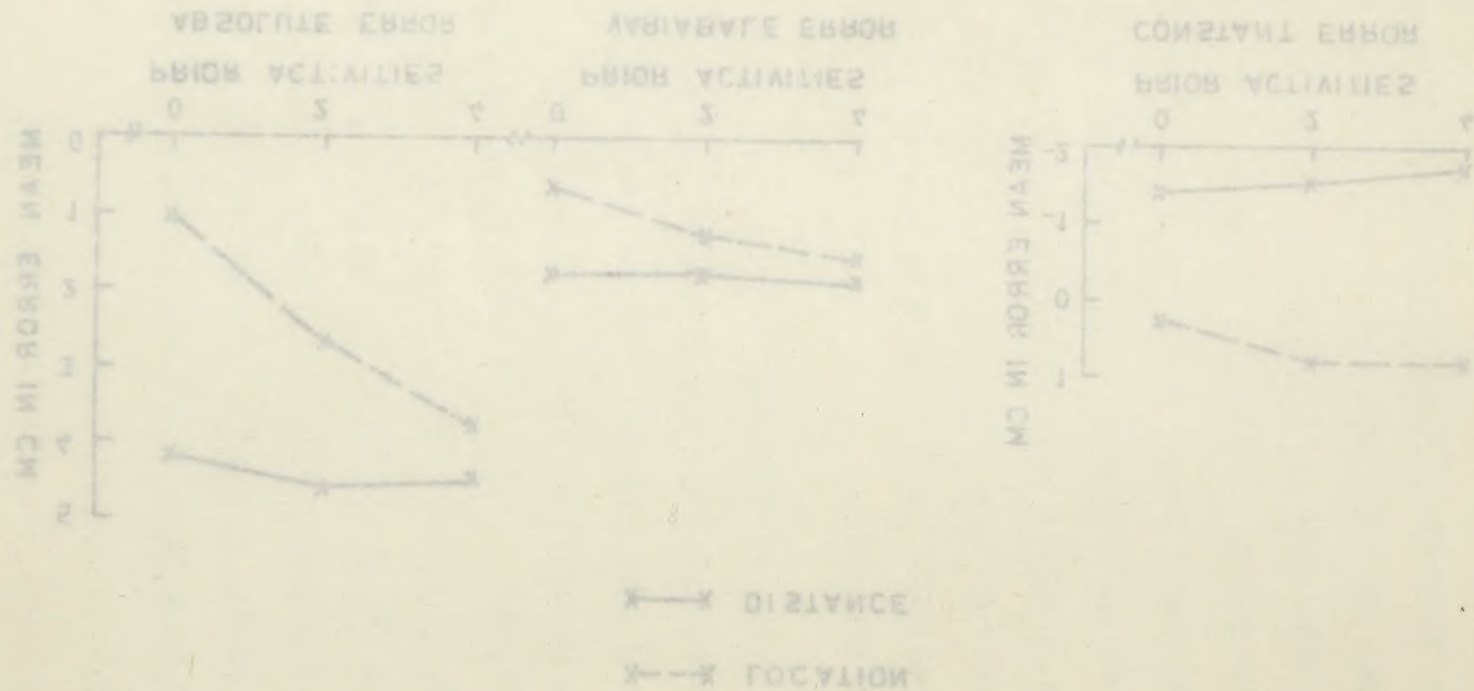


FIG. 3.5.6 MEAN RECALL ERRORS OF SUBJECTS AS A FUNCTION OF PRIOR ACTIVITES IN RECALL OF LOCATIONS AND DISTANCES


ABSOLUTE ERROR
VARIABLE ERROR
CONSTANT ERROR
PRIOR ACTIVITIES
PRIOR ACTIVITIES
PRIOR ACTIVITIES
MEAN ERROR IN FEET
MEAN ERROR IN FEET
0
1
2
3
4
5
-5
-4
-3
-2
-1
0
1
2
3
4
DISTANCE
LOCATION

3.148 Tables 3.5.4, 3.5.5, and 3.5.6 show that a number of second order interaction effects are significant in AE, VE and CE analyses. Groups x informations x retention intervals interaction effect is significant for AE, $\underline{F}$ (2,48) = 31.02, $p < .01$, and VE, $\underline{F}$ (2,48) = 6.69, $p < .01$. Both blind and sighted subjects do not show much loss of recall accuracy for location targets as a function retention intervals. The blind subjects were initially poorer than the sighted subjects in reproduction of the distance targets but on the 50 sec retention intervals the sighted subjects perform slightly poorer than those in the blind group. These results are shown in Fig. 3.5.7.

Another second order interaction effect concerning groups x informations x targets, is significant for AE, $\underline{F}$ (2,48) = 97.20, $p < .01$; VE, $\underline{F}$ (2,48) = 4.08, $p < .05$, and CE, $\underline{F}$ (2,48) = 13.47, $p < .01$. The mean scores for this interaction effect are presented in Fig. 3.5.8. It shows that the performance of the sighted group is superior to the blind group in reproduction of short location targets but on a long location target this pattern reversed. In reproduction of distance, the blind subjects are significantly poorer than the sighted on long target only. The analysis of CE data indicates that the blind group overestimates short distance target and underestimates the long distance target significantly more than the sighted counterparts. In reproduction of location, the sighted

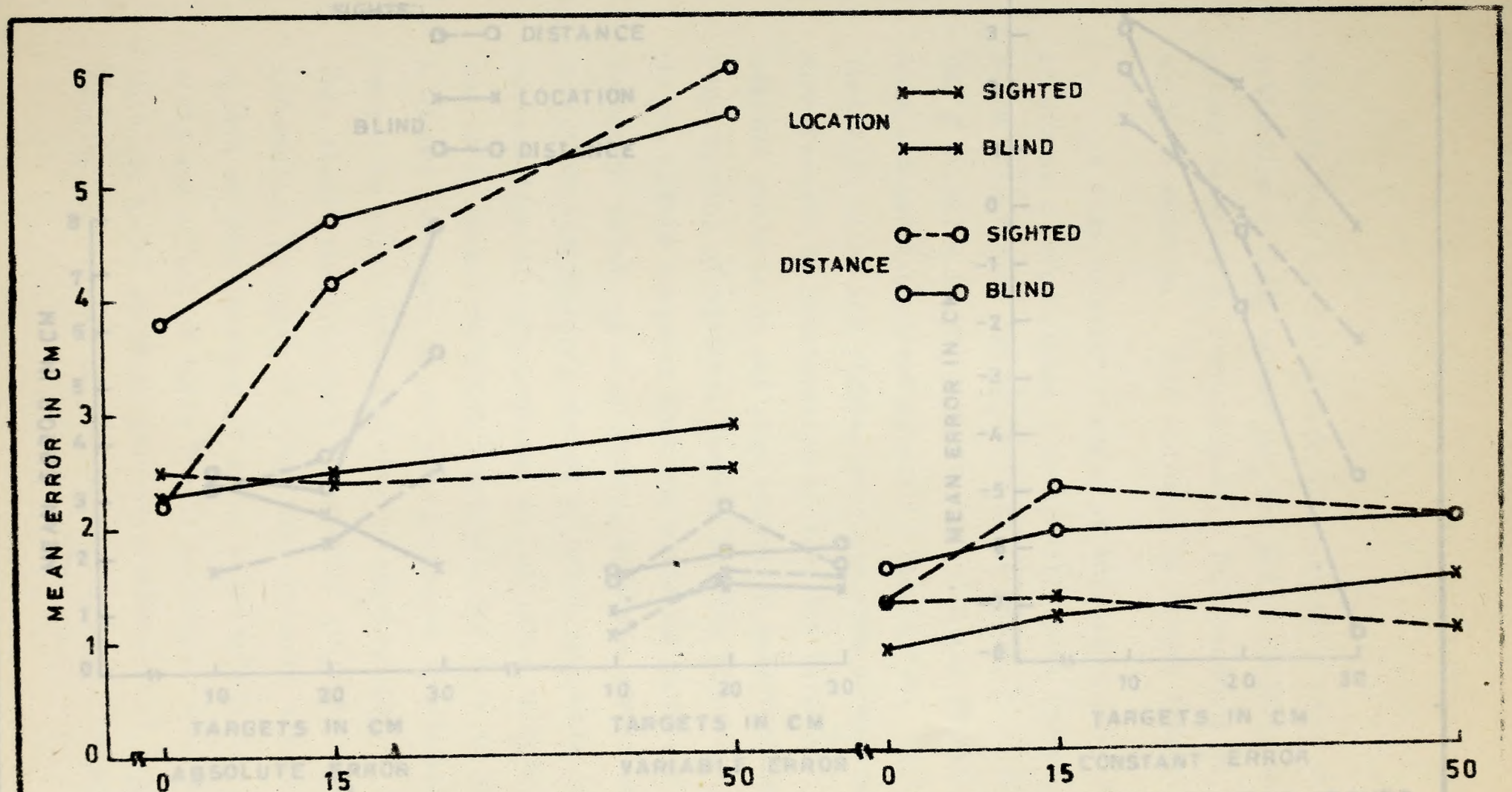
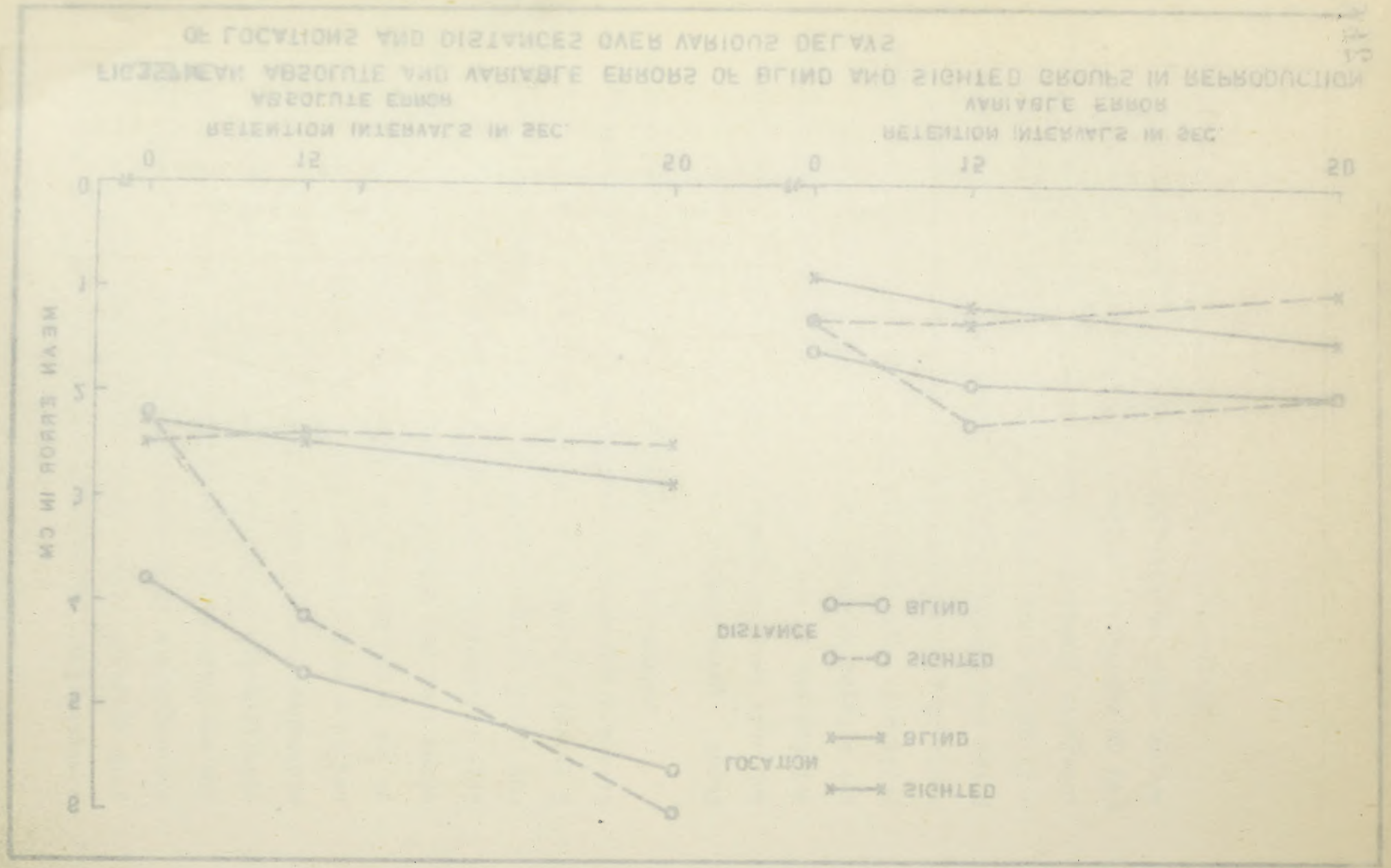


FIG. 3.5 MEAN ABSOLUTE AND VARIABLE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES OVER VARIOUS DELAYS


0
5
10
15
20
CM IN ROOM MEAN
RETENTION INTERVALS IN SEC.
DISTANCE
BLIND
SIGHTED
LOCATION
BLIND
SIGHTED

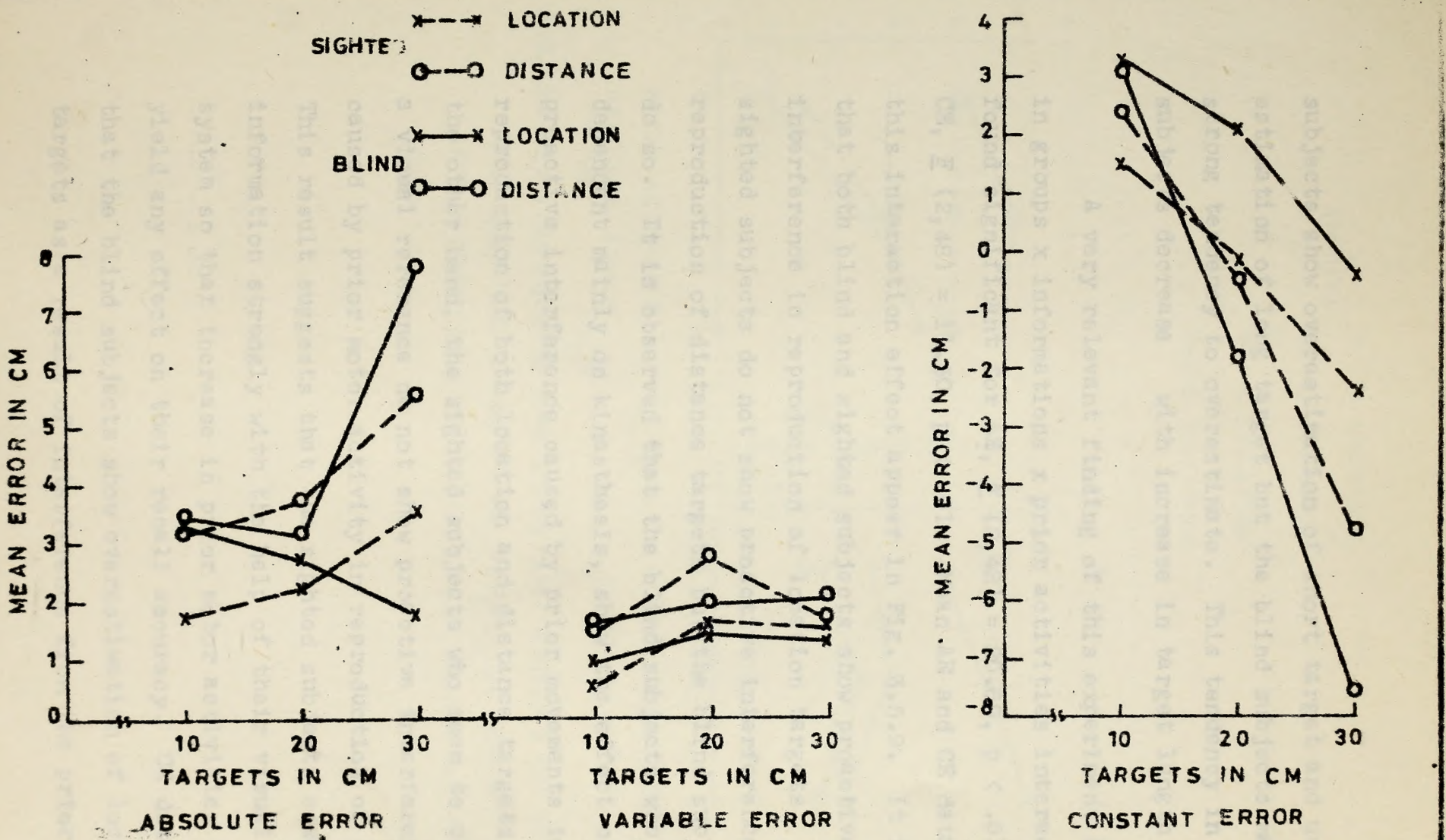


FIG.3.5.8 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF 10-,20- AND 30-CM TARGETS

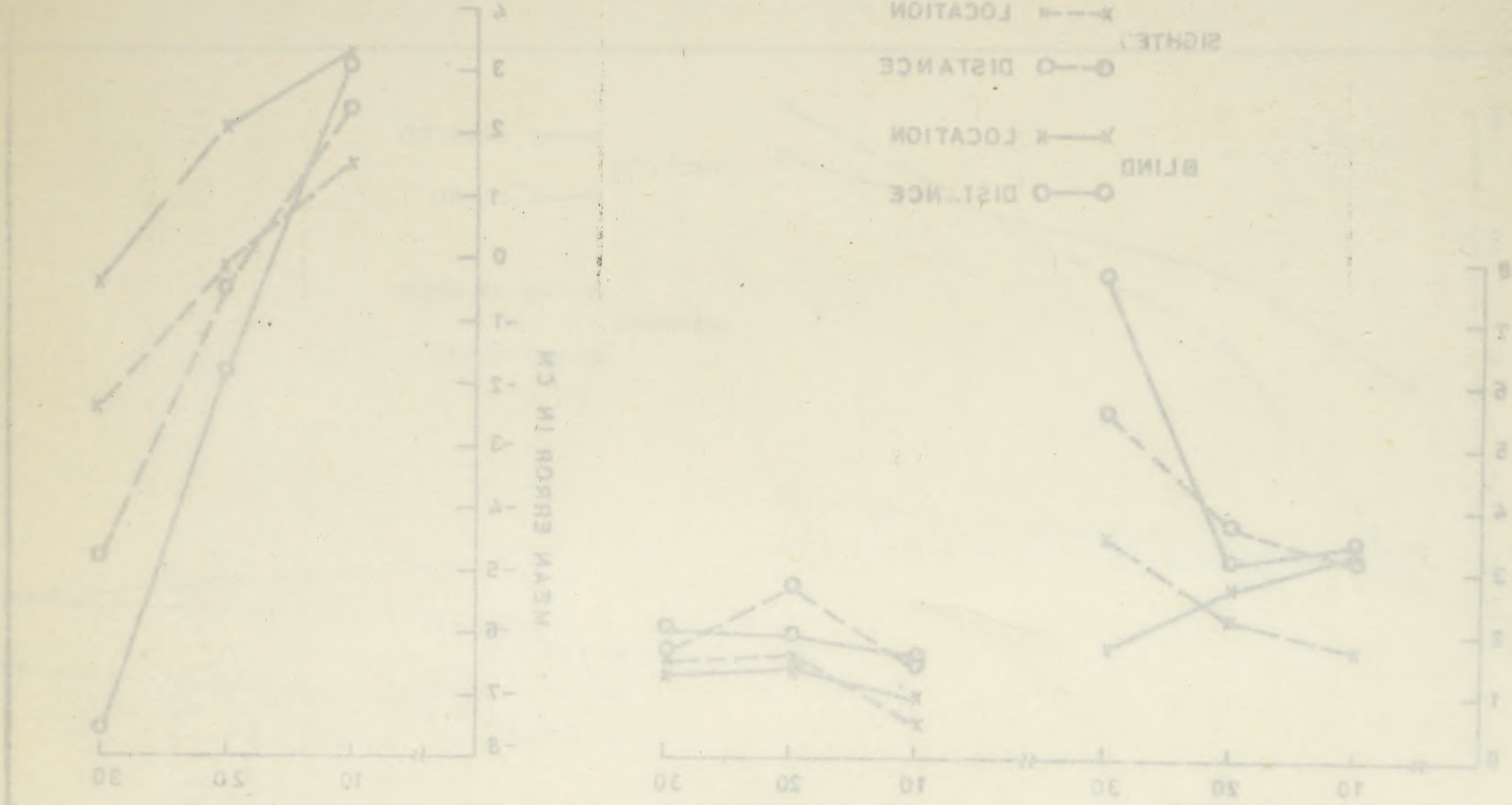


FIG.3.5 MEAN ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF 10-,20- AND 30-C M TARGETS

3.149 subjects show overestimation of short target and underestimation of long target but the blind subjects manifest a strong tendency to overestimate. This tendency in blind subjects decrease with increase in target length.

A very relevant finding of this experiment is obtained in groups x informations x prior activities interaction effect found significant for AE, $\underline{F}$ (2,48) = 20.69, $p < .01$; and CE, $\underline{F}$ (2,48) = 11.30, $p < .01$. Mean AE and CE data for this interaction effect appear in Fig. 3.5.9. It indicates that both blind and sighted subjects show proactive interference in reproduction of location targets. The sighted subjects do not show proactive interference in reproduction of distance targets but the blind subjects do so. It is observed that the blind subjects who are dependent mainly on kinesthesis, show the effect of proactive interference caused by prior movements in reproduction of both location and distance targets. On the other hand, the sighted subjects who seem to utilize a visual reference do not show proactive interference effect caused by prior motor activity in reproduction of distance. This result suggests that the sighted subjects code distance information strongly with the help of their visual reference system so that increase in prior motor activities fails to yield any effect on their recall accuracy. CE data indicate that the blind subjects show overestimation of location targets as a result of interference from the prior activities,

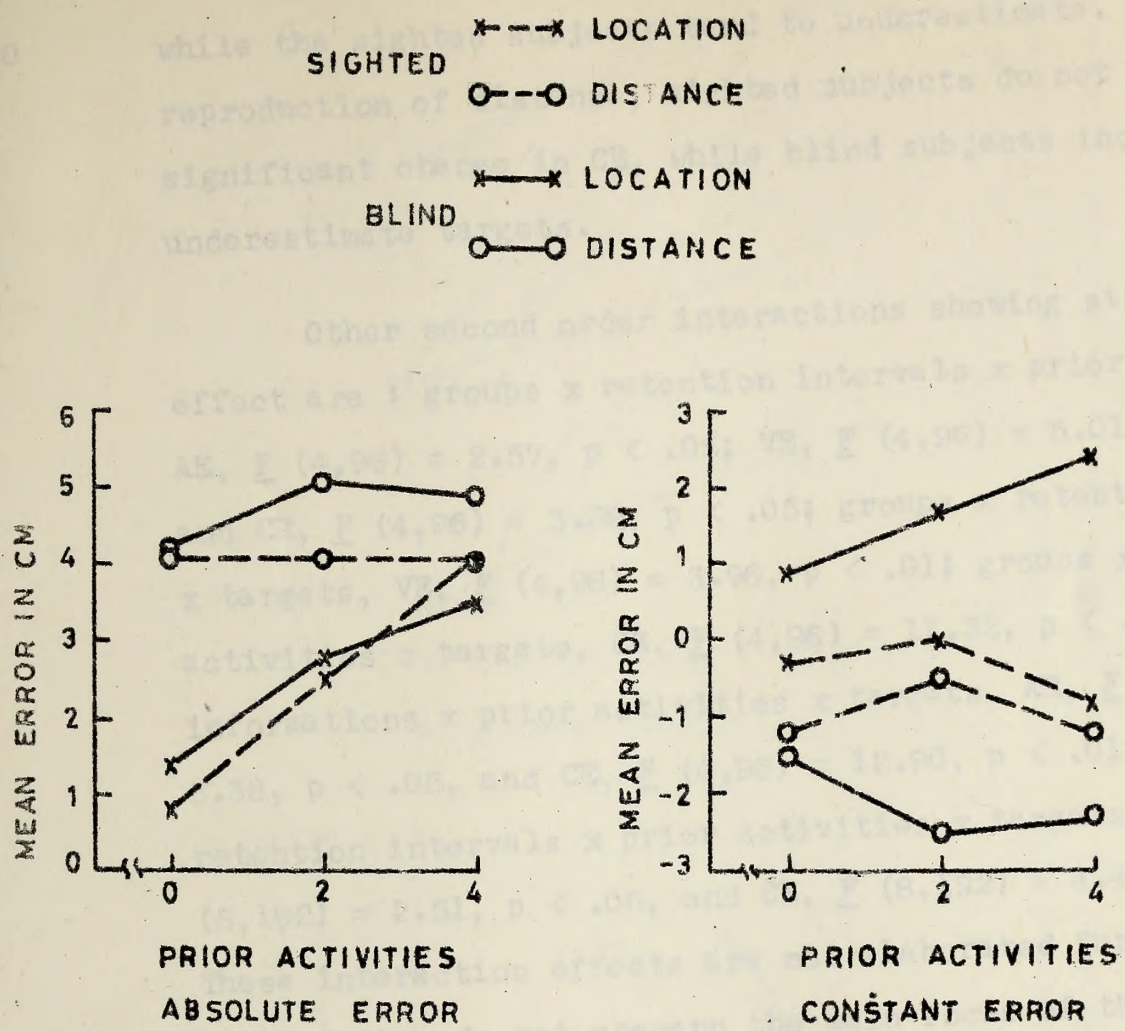


FIG.3.5.9 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES UNDER DIFFERENT PRIOR ACTIVITY CONDITIONS

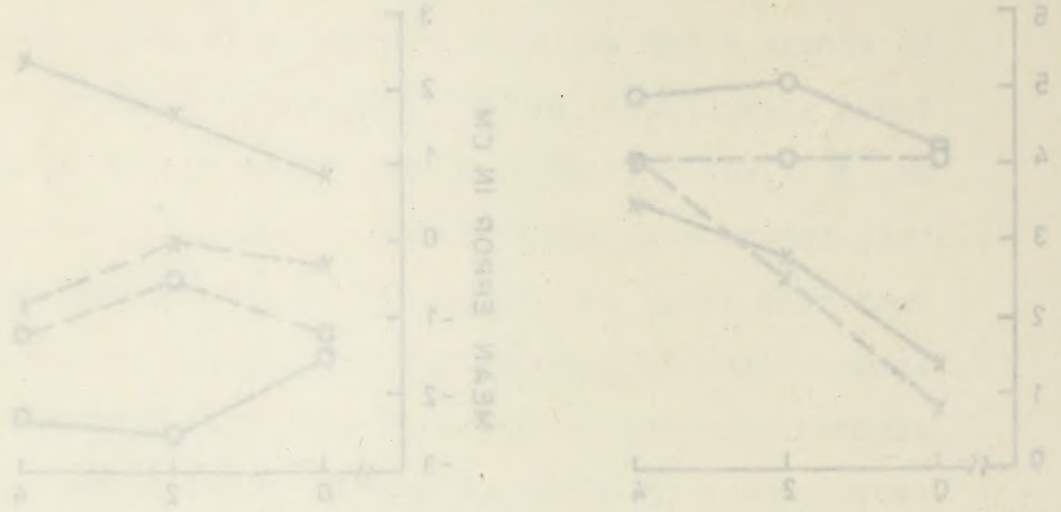


FIG.3.5.9 MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCATIONS AND DISTANCES UNDER DIFFERENT PRIOR ACTIVITY CONDITIONS

3.150 while the sighted subjects tend to underestimate. In reproduction of distance, sighted subjects do not show any significant change in CE, while blind subjects increasingly underestimate targets.

Other second order interactions showing significant effect are : groups x retention intervals x prior activities, AE, $\underline{F}$ (4,96) = 2.57, $p < .05$; VE, $\underline{F}$ (4,96) = 5.01, $p < .01$, and CE, $\underline{F}$ (4,96) = 3.39, $p < .05$; groups x retention intervals x targets, VE, $\underline{F}$ (4,96) = 3.96, $p < .01$; groups x prior activities x targets, CE, $\underline{F}$ (4,96) = 11.32, $p < .01$; informations x prior activities x targets, AE, $\underline{F}$ (4,96) = 3.38, $p < .05$, and CE, $\underline{F}$ (4,96) = 12.90, $p < .01$; and retention intervals x prior activities x targets, AE, $\underline{F}$ (8,192) = 2.51, $p < .05$, and CE, $\underline{F}$ (8,192) = 4.40, $p < .01$. These interaction effects are not elaborated further because some of them do not concern the main focus of this research work; others will be discussed in subsequent paragraphs.

An important third order interaction effect of groups x informations x prior activities x targets is found significant for AE, $\underline{F}$ (4,96) = 14.73, $p < .01$; and CE, $\underline{F}$ (4,96) = 8.85, $p < .01$. It is revealed from Fig. 3.5.10 that under 0 prior activity condition groups differ in reproduction of short location targets and this difference is reduced at long location targets. It seems that in reproduction of short location targets, the sighted subjects

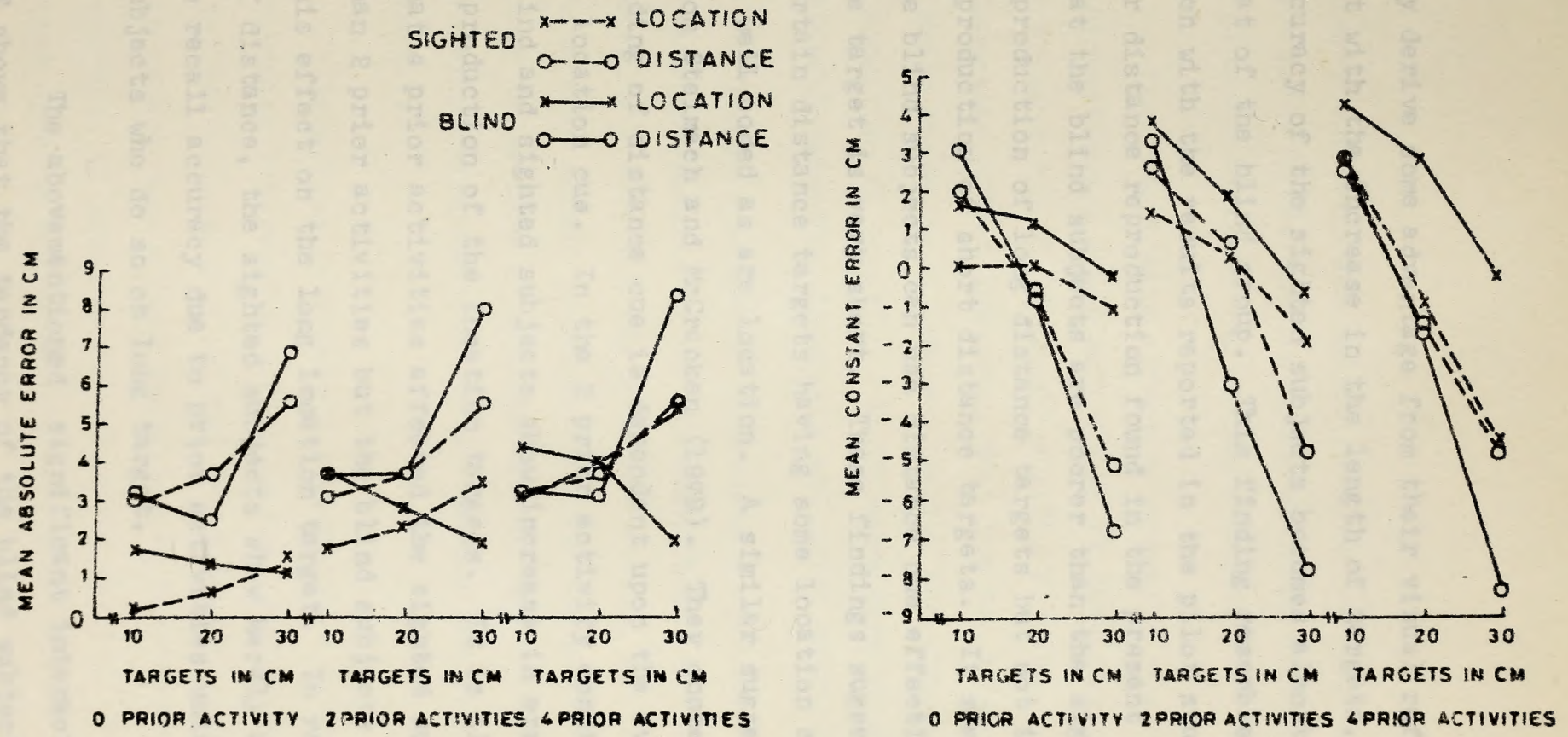
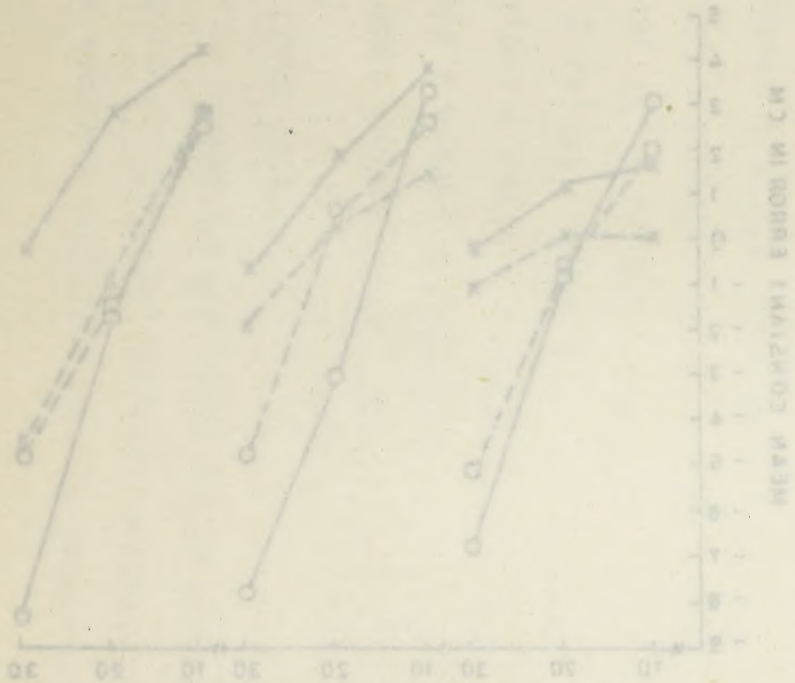
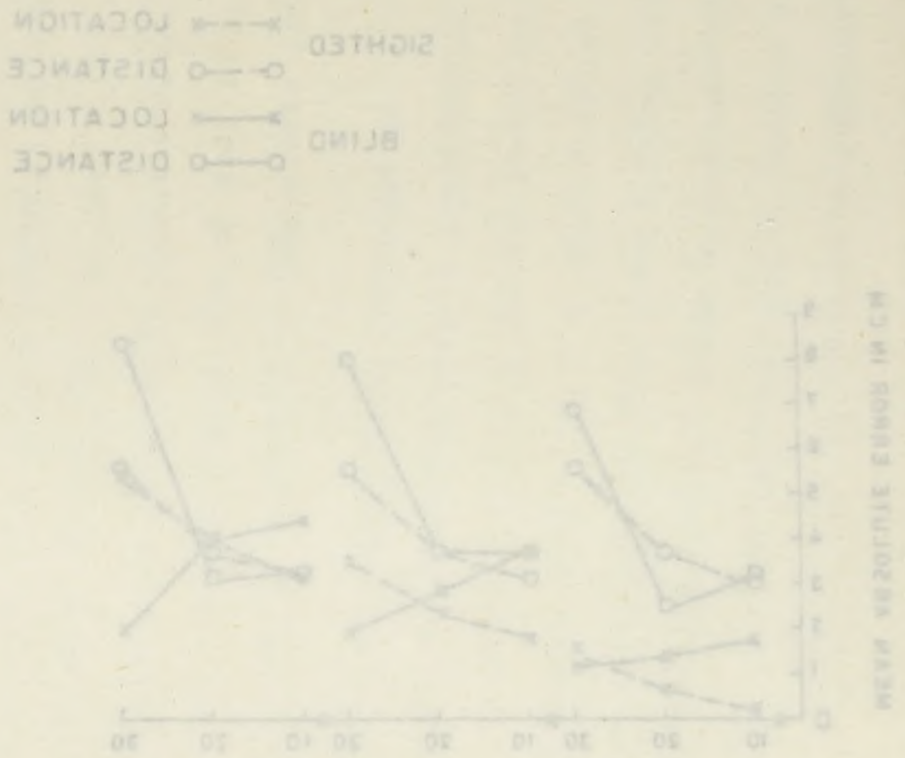


FIG. 3·5·10. MEAN ABSOLUTE AND CONSTANT ERROR OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF LOCTION AND DISTANCES (10/20/30 CM) UNDER DIFFERENT PRIOR ACTIVITY CONDITIONS





3.151 may derive some advantage from their visual reference system but with the increase in the length of targets, recall accuracy of the sighted subjects becomes almost equal to that of the blind group. This finding resembles very much with the results reported in the pilot study. Results for distance reproduction found in the present study indicate that the blind subjects are poorer than the sighted in reproduction of long distance targets but not in reproduction of short distance targets. It seems that the blind subjects can use distance cue effectively if the target is very short. These findings suggest that certain distance targets having some location cue will be as well coded as are location. A similar suggestion comes from Stelmach and McCracken (1978). They contend that coding of distance cue is dependent upon the availability of location cue. In the 2 prior activity condition both blind and sighted subjects show increase in error in reproduction of the location targets. It is also found that 4 prior activities affected the sighted subjects more than 2 prior activities but the blind subjects do not show this effect on the long location target. In reproduction of distance, the sighted subjects show hardly any change in recall accuracy due to prior activities unlike the blind subjects who do so on long target.

The abovementioned significant interaction effect for CE shows that the tendency of the blind subjects to over-

3.152 estimate/underestimate short and long targets with 0, 2 and 4 prior activities is different from the sighted subjects on location and distance tasks.

The interaction effect of groups x retention intervals x informations x prior activities is statistically significant for CE, $\underline{F}$ (4,96) = 3.23, $p < .05$. This interaction effect indicates that the two groups differ in their tendency of underestimation and overestimation in reproduction of location and distance targets under different retention intervals and prior activity conditions.

Groups x retention intervals x informations x targets interaction effect is significant for VE, $\underline{F}$ (4,96) = 4.77, $p < .01$; and CE, $\underline{F}$ (4,96) = 7.23, $p < .01$. This interaction effect suggests that the two groups differ in VE and CE pattern in reproduction of two informations involving different lengths of targets and retention intervals.

Retention intervals x informations x targets x prior activities interaction effect is also significant for AE, $\underline{F}$ (8,192) = 2.62, $p < .01$ and CE, $\underline{F}$ (8,192) = 2.16, $p < .05$. This interaction effect suggests the variations in retention properties of location and distance targets under different target lengths and prior activity conditions.

3.153 Vertical Task. Appendices 3.XV, 3.XVI and 3.XVII report the raw scores of subjects obtained in AE, VE and CE analyses, respectively. Means and S.D. of groups for AE, VE and CE are given in Tables 3.5.7, 3.5.8 and 3.5.9, respectively.

The effect of independent variables and their interactions were examined in 5-way ANOVA test (2 x 2 x 3 x 3 x 3) employed separately for AE, VE and CE. A summary of these ANOVA tests is presented in Tables 3.5.10, 3.5.11, and 3.5.12, respectively.

On this task, effect of groups is significant only for AE, F (1,24) = 11.95, $p < .01$. Mean AE for the blind group (3.64 cm) is significantly larger than that of the sighted group(3.19 cm).

Main effect of informations is significant AE, F (1,24) = 4.49, $p < .05$, and CE, F (1,24) = 51.05, $p < .01$, analysis only. Mean AE for distance information (3.55 cm) is larger than that of location information (3.28 cm). It is clear from the mean CE data that location targets are slightly overestimated (0.07 cm), while distance targets are underestimated (-1.49 cm).

Retention interval has also been found a significant factor in forgetting of motor responses: AE, F (2,48) = 119.87, $p < .01$; VE, F (2,48) = 5.70, $p < .01$; and CE, F (2,48) = 38.44, $p < .01$. Retention intervals of

3.154

TABLE 3.5.7

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGETS (T) AND PRIOR ACTIVITY (PA) CONDITIONS

R.I. (sec)	T (sec)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	1.50(0.24)	0.20(0.08)	2.3 (0.61)	2.23(0.72)
		2	1.68(0.36)	1.76(0.17)	2.77(0.68)	1.93(1.05)
		4	1.63(0.23)	3.20(0.33)	3.28(0.87)	2.37(0.94)
	20	0	1.99(0.30)	0.51(0.21)	2.02(0.75)	2.16(0.72)
		2	2.07(0.29)	1.86(0.23)	2.34(0.75)	2.84(0.44)
		4	2.03(0.17)	3.39(0.22)	3.06(0.94)	2.85(1.33)
	30	0	3.11(0.47)	1.42(0.30)	1.28(0.61)	4.53(1.08)
		2	3.05(0.52)	3.04(0.25)	2.30(0.84)	5.36(1.18)
		4	3.19(0.36)	5.12(1.27)	2.58(0.54)	6.11(1.89)
15	10	0	2.75(0.34)	0.21(0.04)	1.93(0.53)	3.76(1.16)
		2	2.70(0.27)	1.40(0.15)	3.09(0.88)	2.75(1.10)
		4	2.91(0.31)	3.04(0.20)	3.61(1.40)	2.81(0.90)
	20	0	3.42(0.39)	0.71(0.09)	1.64(0.55)	3.17(0.87)
		2	3.39(0.40)	2.04(0.23)	1.97(0.38)	4.31(1.26)
		4	3.32(0.53)	3.33(0.36)	2.30(0.90)	4.01(0.94)
	30	0	5.55(0.87)	1.59(0.26)	1.19(0.61)	6.08(1.86)
		2	5.28(0.90)	2.96(0.31)	2.51(0.68)	8.03(1.24)
		4	5.24(0.77)	4.82(0.47)	2.56(1.13)	8.64(2.57)
50	10	0	4.34(0.35)	0.27(0.12)	2.45(1.03)	4.41(1.18)
		2	4.39(0.18)	1.99(0.21)	3.82(1.35)	4.60(1.76)
		4	4.47(0.34)	3.09(0.15)	3.89(1.39)	4.54(1.81)
	20	0	5.56(0.55)	0.58(0.13)	1.64(0.70)	3.73(1.82)
		2	5.35(0.37)	2.43(0.27)	2.14(0.53)	4.85(1.50)
		4	5.34(0.43)	3.51(0.27)	2.81(0.70)	4.41(1.48)
	30	0	8.22(0.76)	1.39(0.25)	2.00(0.91)	9.13(2.76)
		2	8.41(0.86)	3.43(0.27)	2.73(1.01)	9.68(0.96)
		4	8.82(0.52)	5.11(0.40)	2.98(1.21)	10.06(2.11)

3.155

TABLE 3.5.8

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION TARGETS UNDER RETENTION INTERVAL (RI), TARGETS (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (sec)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	0.52(0.40)	0.19(0.07)	0.53(0.27)	0.89(0.42)
		2	0.32(0.13)	0.89(0.62)	0.81(0.38)	1.54(1.26)
		4	0.57(0.47)	0.60(0.81)	0.88(1.07)	1.27(1.07)
	20	0	1.60(0.49)	0.30(0.15)	0.80(0.39)	1.33(0.63)
		2	1.98(0.29)	1.73(0.21)	0.29(0.79)	2.02(0.60)
		4	1.28(0.96)	2.38(1.39)	1.80(1.65)	1.80(1.11)
	30	0	1.11(1.05)	1.42(1.20)	1.39(0.74)	1.38(0.83)
		2	1.17(0.96)	1.78(1.02)	1.38(0.85)	1.45(0.50)
		4	1.01(0.88)	1.60(1.73)	1.96(0.94)	1.78(1.27)
15	10	0	1.15(0.93)	0.21(0.06)	0.88(0.40)	1.15(0.48)
		2	1.28(1.09)	1.14(0.40)	0.68(0.14)	1.06(0.66)
		4	1.15(1.06)	0.65(0.91)	0.84(0.38)	1.40(1.08)
	20	0	2.78(1.16)	0.68(0.16)	0.94(0.48)	2.46(0.79)
		2	2.42(1.12)	1.64(0.61)	1.46(0.69)	2.26(1.65)
		4	2.81(1.22)	2.21(1.33)	2.01(0.73)	2.70(1.09)
	30	0	1.11(1.10)	1.19(0.48)	1.10(0.61)	1.19(0.68)
		2	2.58(2.13)	1.10(1.14)	1.79(0.76)	1.63(1.07)
		4	2.17(1.94)	1.09(1.19)	1.73(0.82)	1.71(0.56)
50	10	0	1.03(1.18)	0.25(0.14)	1.42(0.45)	1.63(1.07)
		2	1.35(1.63)	0.74(0.72)	1.04(0.38)	1.37(0.45)
		4	1.60(1.70)	1.13(1.18)	0.81(0.65)	1.53(0.95)
	20	0	3.36(2.20)	0.48(0.20)	1.38(0.60)	2.28(1.24)
		2	3.04(2.27)	1.30(0.97)	1.56(0.82)	1.90(1.65)
		4	2.26(2.21)	1.65(1.42)	1.52(0.79)	1.34(0.77)
	30	0	0.95(0.62)	0.49(0.31)	1.61(1.15)	1.94(1.03)
		2	0.80(0.58)	0.47(0.24)	1.87(1.01)	1.90(0.95)
		4	0.75(0.46)	0.57(0.24)	1.60(1.07)	1.74(1.42)

3.156

TABLE 3.5.9

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGETS (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (sec)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	10	0	1.33(0.46)	0.18(0.07)	2.30(0.63)	2.17(0.80)
		2	1.68(0.36)	1.30(0.71)	2.77(0.68)	1.10(0.65)
		4	1.45(0.46)	3.02(0.66)	3.00(1.13)	2.07(1.17)
	20	0	0.34(1.24)	0.18(0.48)	2.02(0.75)	-0.29(2.10)
		2	0.01(0.76)	-0.14(0.83)	1.75(1.22)	-2.23(0.73)
		4	0.15(1.45)	-1.26(1.82)	2.08(1.21)	-1.22(2.38)
	30	0	-2.41(1.58)	-1.05(0.47)	0.28(0.56)	-4.43(1.24)
		2	-2.37(1.58)	-1.99(1.35)	1.03(1.78)	-5.36(1.18)
		4	-2.85(0.90)	-4.21(2.45)	-1.21(1.71)	-6.11(1.89)
15	10	0	2.20(1.08)	0.11(0.17)	1.93(0.53)	3.71(1.20)
		2	2.08(0.81)	0.76(0.60)	3.09(0.88)	2.27(1.81)
		4	2.49(0.65)	2.82(0.59)	3.58(1.47)	2.98(0.79)
	20	0	-0.61(1.77)	0.06(0.32)	1.45(0.59)	-0.77(2.40)
		2	-1.76(1.46)	-0.32(1.21)	0.69(1.49)	-3.65(1.34)
		4	1.10(1.13)	-1.76(1.47)	1.02(1.16)	-2.67(2.05)
	30	0	-5.28(1.46)	-0.75(0.87)	-0.49(0.65)	-5.89(2.29)
		2	-3.63(2.48)	-2.46(0.86)	-1.46(1.47)	-8.03(1.24)
		4	-3.68(2.88)	-4.54(1.01)	-1.96(1.41)	-8.64(2.57)
50	10	0	3.99(1.15)	0.20(0.05)	2.29(1.21)	4.13(1.56)
		2	3.86(0.80)	1.71(0.56)	3.82(1.35)	4.55(1.84)
		4	3.86(0.87)	2.61(0.82)	3.89(1.39)	4.35(1.97)
	20	0	-0.01(4.38)	-0.19(0.34)	0.95(1.10)	-1.18(3.65)
		2	-1.51(3.93)	-1.50(1.25)	0.91(1.40)	-4.46(1.41)
		4	-3.23(3.28)	-2.48(1.56)	2.56(0.95)	-4.18(2.02)
	30	0	-8.22(0.76)	-1.33(0.33)	-0.78(1.32)	-8.90(3.23)
		2	-8.41(0.86)	-3.43(0.27)	-1.30(2.04)	-9.68(0.96)
		4	-8.82(0.52)	-5.11(0.40)	-2.11(1.92)	-10.08(2.11)

3.157

TABLE 3.5.10

SUMMARY OF ANOVA OBTAINED FOR AE ON VERTICAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	905.72	27			
Groups (G)	38.67	1	38.67	11.95	.01
Informations (I)	14.52	1	14.52	4.49	.05
G x I	774.87	1	774.87	239.45	.01
Subjects within groups	77.66	24	3.24		
Within subjects	2735.64	728			
Retention Intervals (R)	397.08	2	198.54	119.87	.01
G x R	7.42	2	3.71	2.24	-
R x I	14.85	2	7.42	4.48	.05
G x R x I	303.25	2	151.62	91.54	.01
R x subjects within groups	79.50	48	1.66		
Prior Activities (P)	202.89	2	101.44	102.82	.01
G x P	13.84	2	6.92	7.02	.01
I x P	52.60	2	26.30	26.66	.01
G x I x P	94.61	2	47.30	47.95	.01
P x subjects within groups	47.36	48	0.99		
Targets (T)	581.50	2	290.75	208.60	.01
G x T	17.70	2	8.85	6.35	.01
I x T	128.07	2	64.04	45.94	.01
G x I x T	335.14	2	167.57	120.22	.01
T x subjects within groups	66.90	48	1.39		

3.157

TABLE 3.3.10

SUMMARY OF ANOVA CONDUCTED FOR AS OF VISUAL
TASK IN EXPERIMENT 3.3

Source	SS	df	MS	F	p
Between subjects	806.72	27			
Groups (G)	38.67	1	38.67	11.95	.01
Informations (I)	14.89	1	14.89	4.49	.05
G x I	993.87	1	774.87	239.48	.01
Subjects within groups	77.66	24	3.24		
Within subjects	2735.64	756			
Retention Intervals (R)	307.08	2	138.84	119.87	.01
G x R	7.42	2	3.71	3.84	-
R x I	14.85	2	7.42	4.42	.05
G x R x I	903.28	2	451.64	91.54	.01
R x subjects within groups	79.80	48	1.66		
Prior Activities (P)	803.89	2	101.44	102.89	.01
G x P	12.94	2	6.92	7.02	.01
I x P	52.60	2	26.30	26.66	.01
G x I x P	94.81	2	47.90	47.95	.01
P x subjects within groups	47.56	48	0.99		
Targets (T)	891.80	2	890.78	108.60	.01
G x T	17.70	2	8.85	6.88	.01
I x T	128.07	2	64.04	45.04	.01
G x I x T	355.14	2	187.87	180.89	.01
T x subjects within groups	66.90	48	1.39		

3.158

TABLE 3.5.10 (CONTD.)

Source	SS	df	MS	F	p
R x P	1.33	4	0.33	0.83	-
G x R x P	1.78	4	0.44	1.11	-
R x I x P	0.95	4	0.24	0.60	-
G x R x I x P	0.32	4	0.08	0.20	-
RP x subjects within groups	38.39	96	0.40		
R x T	42.18	4	10.54	26.86	.01
G x R x T	7.51	4	1.88	4.78	.01
R x I x T	2.28	4	0.57	1.46	-
G x R x I x T	32.40	4	8.10	20.63	.01
RT x subjects within groups	37.69	96	0.39		
P x T	9.83	4	2.46	2.10	-
G x P x T	3.22	4	0.81	0.69	-
I x P x T	13.34	4	3.33	2.85	.05
G x I x P x T	5.89	4	1.47	1.26	-
PT x subjects within groups	112.26	96	1.17		
R x P x T	1.88	8	0.23	0.64	-
G x R x P x T	5.76	8	0.72	1.97	-
I x R x P x T	3.15	8	0.39	1.08	-
G x I x R x P x T	2.43	8	0.30	0.83	-
RPT x subjects within groups	70.33	192	0.37		
Total	3641.36	755			

3.159

TABLE 3.5.11

SUMMARY OF ANOVA OBTAINED FOR VE ON VERTICAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	95.12	27			
Groups (G)	6.75	1	6.75	3.38	-
Information (I)	1.79	1	1.79	0.89	-
G x I	38.59	1	38.59	19.30	.01
Subjects within groups	47.99	24	2.00		
Within subjects	848.61	728			
Retention Intervals (R)	10.30	2	5.15	5.70	.01
G x R	4.46	2	2.23	2.47	-
R x I	8.00	2	4.00	4.43	.05
G x R x I	11.67	2	5.83	6.46	.05
R x subjects within groups	43.38	48	0.90		
Prior activities (P)	15.17	2	7.59	7.40	.01
G x P	2.24	2	1.12	1.09	-
I x P	2.80	2	1.40	1.37	-
G x I x P	8.54	2	4.27	4.17	.05
P x subjects within groups	49.17	48	1.02		
Targets (T)	89.03	2	44.51	29.31	.01
G x T	13.28	2	6.64	4.37	.05
I x T	2.13	2	1.06	0.70	-
G x I x T	13.57	2	6.78	4.47	.05

3.160

TABLE 3.5.11 (CONTD.)

Source	SS	df	MS	F	p
T x subjects within groups	72.91	48	1.52		
R x P	7.98	4	2.00	2.29	-
G x R x P	2.49	4	0.62	0.71	-
R x I x P	2.65	4	0.66	0.76	-
G x R x I x P	1.33	4	0.33	0.38	-
RP x subjects within groups	83.81	96	0.87		
R x T	11.64	4	2.91	2.83	.05
G x R x T	12.25	4	3.06	2.98	.05
R x I x T	5.17	4	1.29	1.25	-
G x R x I x T	1.89	4	0.47	0.46	-
RT x subjects within groups	98.81	96	1.03		
P x T	1.33	4	0.33	0.33	-
G x P x T	1.05	4	0.26	0.26	-
I x P x T	3.70	4	0.93	0.91	-
G x I x P x T	13.72	4	3.43	3.38	.05
PT x subjects within groups	97.31	96	1.01		
R x P x T	7.42	8	0.93	0.27	-
G x R x P x T	3.55	8	0.44	0.61	-
I x R x P x T	2.58	8	0.32	0.44	-
G x I x R x P x T	3.39	8	0.42	0.58	-
RPT x subjects within groups	139.88	192	0.73		
Total	943.73	755			

3.161

TABLE 3.5.12

SUMMARY OF ANOVA OBTAINED FOR CE ON VERTICAL TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	1370.69	27			
Groups (G)	23.18	1	23.18	2.57	-
Informations (I)	460.96	1	460.96	51.05	.01
G x I	669.85	1	669.85	74.19	.01
Subjects within groups	216.70	24	9.03		
Within subjects	8991.07	728			
Retention Intervals (R)	128.48	2	64.24	38.44	.01
G x R	16.42	2	8.29	4.91	.05
R x I	0.85	2	0.43	0.25	-
G x R x I	34.53	2	17.27	10.33	.01
R x subjects within groups	80.21	48	1.67		
Prior Activities (P)	48.88	2	24.44	4.28	.05
G x P	6.14	2	3.07	0.54	-
I x P	48.97	2	24.48	4.29	.05
G x I x P	17.09	2	8.55	1.50	-
P x subjects within groups	273.81	48	5.70		
Targets (T)	5367.55	2	2683.77	479.54	.01
G x T	49.14	2	24.57	4.39	.05
I x T	95.46	2	47.73	8.53	.01
G x I x T	793.61	2	396.81	70.90	.01
T x subjects within groups	268.63	48	5.60		

.162

TABLE 3.5.12 (CONTD.)

Source	SS	df	MS	F	p
R x P	8.97	4	2.24	1.75	-
G x R x P	22.47	4	5.62	4.39	.01
R x I x P	13.12	4	3.28	2.56	.05
G x R x I x P	10.09	4	2.52	1.96	-
RP x subjects within groups	122.83	96	1.28		
R x T	443.66	4	110.92	45.88	.01
G x R x T	13.28	4	3.32	1.37	-
R x I x T	16.46	4	4.12	1.70	-
G x R x I x T	202.33	4	50.58	20.92	.01
RT x Subjects within groups	232.10	96	2.42		
P x T	173.96	4	43.49	34.94	.01
G x P x T	17.12	4	4.28	3.44	.05
I x P x T	42.33	4	10.58	8.50	.01
G x I x P x T	80.98	4	20.24	16.26	.01
PT x subjects within groups	119.49	96	1.24		
R x P x T	15.37	8	1.92	2.07	.05
G x R x P x T	11.96	8	1.49	1.61	-
I x R x P x T	6.42	8	0.80	0.86	-
G x I x R x P x T	29.78	8	3.72	4.00	.01
RPT x subjects within groups	178.56	192	0.93		
Total	10361.77	755			

.163 0 sec, 15 sec and 50 sec yielded mean AE scores of 2.58 cm, 3.31 cm and 4.35 cm, mean VE scores of 1.23 cm, 1.51 cm and 1.41 cm, and mean CE scores of -0.19 cm, -0.74 cm and -1.20 cm, respectively. These results indicate that recall responses become more variable with delay in recall. Moreover, as a result of fading of traces the subjects show increase in underestimating the targets.

Proactive inhibition was seen to have strong effect. As the number of prior activities increased (e.g. 0, 2 and 4) both mean AE (e.g., 2.75 cm, 3.48 cm and 4.01 cm, respectively) and mean VE (e.g. 1.18 cm, 1.47 cm and 1.50 cm, respectively) increased. Mean differences for AE, $\underline{F}$ (2,48) = 102.82, $p < .01$ and for VE, $\underline{F}$ (2,48) = 7.40, $p < .01$ are statistically significant. CE analysis revealed increasing underestimation as a result of increase in the number of prior activities. For 0, 2 and 4 prior activities mean CE scores are -0.35 cm, -0.84 cm, and -0.93 cm, respectively, the difference among these CE means being statistically significant, $\underline{F}$ (2,48) = 4.28, $p < .01$.

Main effect of targets is also significant in all the three error analyses: AE, $\underline{F}$ (2,48) = 208.60, $p < .01$, VE, $\underline{F}$ (2,48) = 29.31, $p < .01$; and CE, $\underline{F}$ (2,48) = 479.54, $p < .01$. For 10 cm, 20 cm and 30 cm targets mean AE scores are 2.73 cm, 2.86 cm and 4.65 cm, mean VE scores are 0.96 cm, 1.80 cm and 1.39 cm, and mean CE scores are 2.48 cm,

3.164 -0.56 cm and -4.05 cm, respectively. These scores indicate high variability and underestimation of targets at recall.

Several first order interactions were also found significant. A very interesting interaction among these is a groups x informations interaction which is significant in all the three error analyses: AE, $\underline{F}$ (1,24) = 239.45; $p < .01$; VE, $\underline{F}$ (1,24) = 19.30; $p < .01$; and CE, $\underline{F}$ (1,24) = 74.19, $p < .01$. This interaction effect indicates that the blind group is poorer than their sighted counterpart in reproduction of distance information, while the reverse is true for location information. This indicates that blind subjects make effective use of a location cue with the help of their kinesthetic modality which is sharpened in them owing their reliance on it. However, they lag behind their sighted counterparts in distance reproduction which, probably, could be coded with the help of vision. It is clear from the CE data that the sighted subjects show a tendency to underestimate both location and distance targets. The blind subjects, on the other hand, show a tendency to overestimate location but underestimate distance targets. On horizontal task this interaction was found significant only in CE analysis. Clear cut support for this interaction effect are available in Experiment 3.4.

Most interesting among the second order interaction effects found significant is a groups x informations x prior activities interaction effect: AE, $\underline{F}$ (2,48) = 47.95, $p < .01$,

3.165 and VE, F (2,48) = 4.17, $p < .01$. This interaction effect was also found significant in the analysis of the horizontal task and hence no further explanation to account for it is required.

Groups x informations x prior activities x targets interaction was found significant for VE, F (4,96) = 3.38, $p < .05$, and CE, F (4,96) = 16.26, $p < .01$. This interaction effect suggests that the two group were affected by prior activities in the reproduction short/long location and distance targets. Several other third order interactions were also found significant which were observed significant in the analysis of horizontal task also. Therefore, these interaction effects are not described in detail in this section.

Curvilinear Task. Raw scores of subject obtained on this task for AE, VE and CE are reported in Appendices 3.XVIII, 3.XIX, and 3.XX. Means and S.D. of the groups on all experimental conditions for AE, VE and CE analyses are reported in Tables 3.5.13, 3.5.14, and 3.5.15, respectively.

All the three error data were subjected to an ANOVA test separately as employed in the previous two tasks. Summary of these ANOVA results is reported in Tables 3.5.16, 3.5.17 and 3.5.18.

3.166

TABLE 3.5.13

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGET (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (deg.)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	30	0	1.00(0.78)	5.21(1.28)	1.68(0.98)	10.14(3.72)
		2	6.00(1.31)	5.00(0.97)	5.00(3.43)	12.46(5.51)
		4	10.79(1.69)	5.29(0.49)	5.54(1.86)	15.39(8.88)
	70	0	2.32(1.86)	8.18(1.53)	2.04(1.31)	9.61(2.76)
		2	7.89(1.33)	8.43(1.47)	5.71(2.88)	12.39(5.12)
		4	12.11(2.26)	8.96(1.33)	6.79(2.84)	11.18(5.88)
	110	0	4.53(2.52)	13.14(1.24)	2.32(1.15)	20.14(7.92)
		2	10.39(1.39)	13.29(1.06)	6.36(2.32)	25.32(6.01)
		4	16.64(2.39)	13.64(0.52)	9.32(2.98)	22.50(7.59)
15	30	0	1.04(0.42)	11.46(3.39)	2.50(0.91)	16.29(5.06)
		2	7.11(3.17)	11.04(3.75)	7.04(4.10)	16.89(10.28)
		4	11.68(2.45)	11.71(4.83)	9.04(2.17)	19.93(7.12)
	70	0	2.07(1.10)	14.32(1.37)	4.43(1.82)	13.46(3.05)
		2	8.75(1.38)	13.89(0.93)	6.68(1.28)	15.89(3.96)
		4	12.39(1.25)	14.14(1.09)	8.89(3.45)	16.04(4.91)
	110	0	4.21(2.15)	20.21(1.09)	5.04(1.34)	25.21(6.85)
		2	11.36(2.86)	19.32(1.14)	10.68(1.96)	32.68(7.68)
		4	16.86(1.99)	20.57(1.32)	10.93(2.58)	29.50(9.67)
50	30	0	1.29(0.89)	16.54(3.09)	4.32(1.58)	22.82(9.80)
		2	7.50(2.88)	16.96(3.27)	9.71(4.66)	28.07(10.61)
		4	13.00(3.91)	18.00(5.52)	11.21(3.89)	31.61(9.30)
	70	0	3.32(0.94)	22.25(3.99)	5.39(1.22)	19.68(5.66)
		2	8.71(0.74)	20.96(2.04)	10.50(2.33)	21.21(4.11)
		4	14.04(3.15)	23.65(3.89)	10.68(1.57)	23.00(5.44)
	110	0	4.29(1.33)	27.39(3.91)	5.82(2.33)	32.36(7.73)
		2	12.82(3.07)	29.89(2.52)	13.89(5.49)	40.21(9.21)
		4	17.68(2.49)	30.53(3.22)	14.46(3.30)	42.07(7.63)

3.167

TABLE 3.5.14

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL (RI), TARGET (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (deg.)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	30	0	0.85(0.42)	1.68(1.69)	1.21(0.41)	6.94(5.60)
		2	1.94(2.06)	2.17(2.02)	3.84(2.10)	7.33(3.70)
		4	2.62(2.91)	2.27(2.43)	4.26(2.40)	10.19(11.28)
	70	0	2.30(1.82)	7.69(1.57)	1.91(1.39)	7.38(4.34)
		2	6.47(2.44)	5.79(2.50)	5.38(3.33)	11.72(5.44)
		4	8.02(3.85)	7.10(3.98)	4.44(2.51)	11.27(6.16)
	110	0	2.14(1.30)	2.11(1.26)	2.48(1.43)	7.15(1.77)
		2	4.26(3.98)	1.95(1.40)	4.70(2.06)	6.02(3.77)
		4	3.34(4.22)	2.28(1.06)	6.44(2.70)	5.84(3.10)
15	30	0	0.97(0.63)	2.89(4.55)	1.60(0.69)	8.14(4.75)
		2	1.46(1.12)	6.09(6.70)	2.49(1.64)	8.90(4.83)
		4	3.68(4.71)	3.03(4.41)	4.56(3.07)	9.84(5.68)
	70	0	1.67(0.31)	8.39(5.82)	3.38(2.63)	12.22(4.61)
		2	2.88(2.99)	9.90(5.69)	5.72(1.09)	12.58(5.65)
		4	6.75(5.49)	12.90(1.43)	5.09(2.47)	11.63(4.95)
	110	0	1.95(1.27)	1.89(1.12)	3.16(1.97)	5.63(3.09)
		2	2.07(2.46)	1.64(0.86)	5.13(1.85)	5.63(2.93)
		4	3.25(3.97)	4.49(6.80)	6.09(3.92)	8.33(4.09)
50	30	0	0.96(0.53)	5.57(7.32)	1.98(0.83)	10.86(5.59)
		2	2.32(3.39)	6.54(8.27)	5.47(3.60)	12.24(5.76)
		4	6.58(6.28)	2.14(1.01)	3.18(2.19)	14.57(10.44)
	70	0	2.67(1.68)	11.83(8.79)	3.69(2.35)	16.68(7.64)
		2	5.56(4.10)	14.14(8.21)	6.40(3.32)	16.51(5.93)
		4	7.63(5.04)	8.24(7.69)	7.89(3.92)	13.26(9.68)
	110	0	0.93(0.69)	4.54(1.74)	3.46(2.64)	7.91(4.72)
		2	3.42(3.04)	3.88(3.44)	3.98(1.98)	6.77(2.98)
		4	1.48(0.58)	2.77(1.71)	5.72(4.39)	8.93'4.19)

3.168

TABLE 3.5.15

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER RETENTION INTERVAL(RI), TARGET (T) AND PRIOR ACTIVITY (PA) CONDITIONS

RI (sec)	T (deg.)	PA	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
0	30	0	0.93(0.85)	4.79(1.70)	1.54(1.11)	7.36(2.70)
		2	5.57(1.41)	3.93(1.98)	4.14(4.48)	11.11(7.10)
		4	10.14(2.56)	3.64(2.80)	3.18(1.94)	11.89(4.70)
	70	0	0.11(1.03)	2.61(2.15)	-0.18(1.37)	3.39(6.26)
		2	-2.54(4.06)	2.36(6.16)	1.14(3.19)	-1.96(5.78)
		4	-7.61(4.93)	-2.89(3.90)	2.79(5.80)	0.11(3.39)
	110	0	-3.82(3.08)	-13.14(1.24)	-1.04(0.70)	-20.14(7.92)
		2	-8.61(2.59)	-13.29(1.06)	-4.00(4.49)	-25.32(6.01)
		4	-15.79(3.48)	-13.64(0.52)	8.39(3.81)	-22.21(8.00)
15	30	0	0.54(0.37)	9.96(4.68)	2.29(1.34)	15.79(6.08)
		2	7.11(3.17)	7.96(2.02)	6.75(4.33)	14.04(12.68)
		4	9.39(5.50)	10.57(5.07)	7.11(5.28)	19.07(7.88)
	70	0	-1.36(1.59)	0.04(11.51)	0.21(3.88)	3.53(5.83)
		2	-6.61(5.15)	-4.11(8.05)	-0.54(4.41)	-3.89(10.83)
		4	-8.68(3.39)	1.14(6.63)	-0.04(8.77)	2.54(13.49)
	110	0	-3.51(2.45)	-20.21(1.09)	-3.04(3.03)	-25.21(6.85)
		2	-9.79(6.14)	-19.32(1.14)	-9.82(3.13)	-32.68(7.68)
		4	-15.79(4.59)	-19.14(2.66)	-8.50(4.39)	-29.50(9.67)
50	30	0	1.07(0.94)	14.11(3.79)	4.18(1.91)	19.04(13.56)
		2	6.64(2.63)	10.82(9.87)	8.93(4.20)	26.50(12.81)
		4	9.71(4.48)	10.43(16.78)	10.29(5.46)	25.82(15.20)
	70	0	-1.46(1.70)	-9.11(16.51)	0.04(4.49)	-0.25(11.73)
		2	-4.50(4.18)	-6.39(13.41)	-4.93(7.73)	-4.50(14.46)
		4	-8.18(8.66)	-5.82(22.49)	-2.32(6.91)	4.93(18.74)
	110	0	-4.29(1.33)	-27.39(3.91)	-4.04(3.62)	-32.36(7.73)
		2	-12.11(4.01)	-29.89(2.52)	-13.53(5.96)	-40.21(9.21)
		4	-17.68(2.49)	-30.53(3.22)	-13.68(2.62)	-42.67(7.63)

RI (sec)	T (deg.)	PA	SIGHTED LOCATION	SIGHTED DISTANCE	BLIND LOCATION	BLIND DISTANCE
0	30	0	0.93(0.86)	4.79(1.70)	1.58(1.11)	7.36(2.90)
		2	5.87(1.41)	3.93(1.96)	4.14(6.18)	11.11(7.10)
		4	10.14(2.86)	8.64(2.80)	8.18(1.94)	11.89(4.70)
	70	0	0.11(1.05)	2.81(2.15)	-0.18(1.37)	3.39(6.86)
		2	-2.54(4.06)	2.36(6.16)	1.14(3.19)	-1.96(5.78)
		4	-7.61(4.93)	-2.89(3.90)	-2.72(8.80)	0.11(8.39)
	110	0	-3.82(3.08)	-13.14(1.24)	-1.04(0.70)	-30.14(7.89)
		2	-8.61(2.89)	-13.29(1.06)	-4.00(4.49)	-28.32(6.01)
		4	-15.79(5.48)	-13.64(0.85)	8.39(3.81)	-22.21(8.00)
15	30	0	0.54(0.37)	9.96(4.68)	2.29(1.34)	16.79(4.08)
		2	7.11(3.17)	7.96(2.05)	6.75(4.33)	14.04(12.39)
		4	9.39(5.80)	10.85(6.07)	7.11(5.99)	19.07(7.88)
	70	0	-1.35(1.59)	0.04(11.51)	0.21(3.88)	5.83(6.83)
		2	-6.61(5.15)	-4.11(8.05)	-0.54(4.41)	-3.89(10.85)
		4	-8.68(5.39)	1.14(6.65)	-0.04(8.77)	8.84(13.49)
	110	0	-3.81(2.45)	-20.21(1.09)	-8.04(3.05)	-28.21(6.85)
		2	-9.79(6.14)	-19.59(1.14)	-9.89(3.15)	-33.88(7.89)
		4	-15.79(4.89)	-19.14(8.66)	-8.80(4.39)	-29.80(9.49)
30	30	0	1.07(0.94)	14.11(3.79)	4.19(1.01)	19.04(13.89)
		2	6.64(2.83)	10.88(9.89)	8.98(4.30)	24.80(19.81)
		4	9.71(4.48)	10.43(16.78)	10.29(5.16)	25.29(9.09)
	70	0	-1.46(1.70)	-9.11(16.81)	0.01(4.10)	-0.58(11.73)
		2	-4.50(4.18)	-6.79(12.41)	-0.93(7.79)	-4.50(14.40)
		4	-8.18(8.98)	-5.88(20.19)	-3.59(6.91)	4.09(18.74)
	110	0	-4.89(1.33)	-27.39(8.81)	-4.04(3.09)	-32.30(7.73)
		2	-12.11(4.01)	-29.89(9.89)	-13.83(6.96)	-40.81(9.31)
		4	-17.68(2.49)	-30.85(8.89)	-13.68(2.69)	-47.07(9.69)

.169

TABLE 3.5.15

SUMMARY OF ANOVA OBTAINED FOR AE ON CURVILINEAR TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	28823.76	27			
Groups (G)	1075.00	1	1075.00	8.10	.01
Informations (I)	22089.26	1	22089.26	166.50	.01
G x I	2475.43	1	2475.43	18.66	.01
Subjects within groups	3184.06	24	132.67		
Within subjects	38327.05	728			
Retention Intervals (R)	8739.12	2	4369.56	269.08	.01
G x R	73.78	2	36.89	2.27	-
R x I	3750.71	2	1875.36	115.49	.01
G x R x I	114.59	2	57.30	3.53	.05
R x subjects within groups	779.46	48	16.24		
Prior Activities (P)	4171.54	2	2085.77	176.24	.01
G x P	124.05	2	62.02	5.24	.01
I x P	1090.96	2	545.48	46.09	.01
G x I x P	655.74	2	327.87	27.70	.01
P x subjects within groups	568.09	48	11.84		
Targets (T)	7210.89	2	3605.44	62.54	.01
G x T	614.99	2	307.50	5.33	.01
I x T	2167.16	2	1083.58	18.80	.01
G x I x T	711.71	2	355.86	6.17	.01
T x subjects within groups	2767.17	48	57.65		

3.170

TABLE 3.5.15 (CONTD.)

Source	SS	df	MS	F	p
R x P	123.76	4	30.94	3.70	.01
G x R x P	15.42	4	3.86	0.46	-
G x I x P	33.32	4	8.33	1.00	-
G x R x I x P	17.19	4	4.30	0.51	-
RP x subjects within groups	802.07	96	8.35		
R x T	102.45	4	25.61	3.90	.01
G x R x T	81.49	4	20.37	3.10	.01
R x I x T	53.30	4	13.32	2.03	-
G x R x I x T	68.31	4	17.08	2.60	.05
RT x subjects within groups	630.20	97	6.56		
P x T	160.41	4	40.10	2.81	.05
G x P x T	5.74	4	13.93	0.98	-
I x P x T	37.31	4	9.33	0.65	-
G x I x P x T	39.41	4	9.85	0.69	-
PT x subjects within groups	1370.98	97	14.28		
R x P x T	48.52	8	6.07	1.11	-
G x R x P x T	33.18	8	4.15	0.76	-
I x R x P x T	36.23	8	4.53	0.83	-
G x I x R x P x T	26.88	8	3.36	0.61	-
RPT x subjects within groups	1050.92	192	5.47		
Total	67150.81	755			

TABLE 3.5.1b (CONTD.)

Source	SS	df	MS	F	P
R x P	1253.70	4	30.94	3.70	.01
G x R x P	18.42	4	3.36	0.45	-
G x I x P	33.32	4	8.33	1.00	-
G x R x I x P	17.19	4	4.30	0.51	-
RP x subjects within groups	802.07	96	8.38		
R x T	102.45	4	25.61	8.80	.01
G x R x T	81.49	4	20.37	3.10	.01
R x I x T	53.30	4	13.32	2.03	-
G x R x I x T	68.21	4	17.08	2.60	.05
RT x subjects within groups	630.20	97	6.56		
P x T	180.41	4	45.10	8.81	.01
G x P x T	5.74	4	1.93	0.38	-
I x P x T	37.31	4	9.33	0.85	-
G x I x P x T	39.41	4	9.85	0.89	-
PT x subjects within groups	1370.38	97	14.08		
R x P x T	48.82	8	6.07	1.11	-
G x R x P x T	33.18	8	4.15	0.76	-
I x R x P x T	36.83	8	4.55	0.83	-
G x I x R x P x T	38.88	8	5.36	0.81	-
RPT x subjects within groups	1030.82	192	5.47		
Total	6718.61	798			

3.171

TABLE 3.5.16

SUMMARY OF ANOVA OBTAINED FOR VE ON CURVILINEAR TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	6833.14	27			
Groups (G)	1384.91	1	1386.91	15.86	.01
Informations (I)	2767.83	1	2767.83	31.70	.01
G x I	584.72	1	584.72	6.70	.05
Subjects within groups	2095.69	24	87.32		
Within subjects	15039.02	728			
Retention Intervals (R)	456.43	2	228.21	9.21	.01
G x R	26.80	2	13.40	0.54	-
R x I	283.70	2	141.85	5.73	.01
G x R x I	45.67	2	22.84	0.92	-
R x subjects within groups	1189.23	48	24.78		
Prior Activities (P)	417.29	2	208.64	17.43	.01
G x P	6.62	2	3.31	0.28	-
I x P	191.28	2	95.64	7.99	.01
G x I x P	49.59	2	24.80	2.07	-
P x subjects within groups	574.73	48	11.97		
Targets (T)	2076.69	2	1038.34	40.76	.01
G x T	140.97	2	70.49	2.77	-
I x T	750.08	2	375.04	14.72	.01
G x I x T	99.26	2	49.63	1.95	-
T x subjects within groups	1222.87	48	25.48		

.172

TABLE 3.5.16 (CONTD.)

Source	SS	df	MS	F	p
R x P	70.99	4	17.75	1.20	-
G x R x P	44.91	4	11.23	0.76	-
R x I x P	87.39	4	21.85	1.47	-
G x R x I x P	60.09	4	15.02	1.01	-
RP x subjects within groups	1425.32	96	14.85		
R x T	143.44	4	35.86	2.14	-
G x R x T	17.81	4	4.45	0.27	-
R x I x T	40.13	4	10.03	0.60	-
G x R x I x T	41.08	4	10.27	0.61	-
RT x subjects within groups	1606.11	96	16.73		
P x T	44.63	4	11.16	1.13	-
G x P x T	78.37	4	19.59	1.98	-
I x P x T	68.59	4	17.15	1.73	-
G x I x P x T	100.15	4	25.04	2.53	.05
PT x subjects within groups	948.96	96	9.89		
R x P x T	46.83	8	5.85	0.47	-
G x R x P x T	78.08	8	9.76	0.78	-
I x R x P x T	99.26	8	12.41	0.99	-
G x I x R x P x T	95.64	8	11.95	0.95	-
RPT x subjects within groups	2410.02	192	12.55		
Total	21872.16	755			

.173

TABLE 3.5.17

SUMMARY OF ANOVA OBTAINED FOR CE ON CURVILINEAR TASK IN EXPERIMENT 3.5

Source	SS	df	MS	F	p
Between subjects	8902.91	27			
Groups (G)	383.57	1	383.57	1.31	-
Informations (I)	1366.76	1	1366.76	4.66	.05
G x I	115.89	1	115.89	0.40	-
Subjects within groups	7036.68	24	293.19		
Within subjects	151943.94	728			
Retention Intervals (R)	655.04	2	327.52	5.55	.01
G x R	113.90	2	66.95	1.14	-
R x I	150.80	2	75.40	1.28	-
G x R x I	248.36	2	124.18	2.11	-
R x subjects within groups	2830.41	48	58.97		
Prior Activities (P)	428.71	2	214.35	3.97	.05
G x P	227.30	2	113.65	2.10	-
I x P	224.78	2	112.39	2.08	-
G x I x P	42.40	2	21.20	0.39	-
P x subjects within groups	2594.57	48	54.05		
Targets (T)	86750.81	2	43375.41	370.30	.01
G x T	2039.04	2	1019.52	8.70	.01
I x T	19291.48	2	9645.74	82.35	.01
G x I x T	3350.94	2	1675.47	14.30	.01
T x subjects within groups	5622.51	48	117.14		

.174

TABLE 3.5.17 (CONTD.)

Source	SS	df	MS	F	p
R x P	141.26	4	35.32	1.16	-
G x R x P	14.79	4	3.70	0.12	-
G x I x P	90.91	4	22.73	0.75	-
G x R x I x P	66.18	4	16.55	0.54	-
RP x subjects within groups	2923.51	96	30.45		
R x T	5799.62	4	1449.91	35.67	.01
G x R x T	283.37	4	70.84	1.74	-
R x I x T	2104.85	4	526.21	12.95	.01
G x R x I x T	114.62	4	28.66	0.71	-
RT x subjects within groups	3901.79	96	40.64		
P x T	2637.31	4	659.33	24.02	.01
G x P x T	300.41	4	75.10	2.74	.05
I x P x T	781.81	4	195.45	7.12	.01
G x I x P x T	699.75	4	174.94	6.37	.01
PT x subjects within groups	2635.13	96	27.45		
R x Px T	246.23	8	30.78	1.45	-
G x R x P x T	200.79	8	25.10	1.18	-
I x R x P x T	285.89	8	35.74	1.68	-
G x I x R x P x T	40.77	8	8.10	0.24	-
RPT x subjects within groups	4083.86	192	21.27		
Total	160846.84	755			

TABLE 3.5.17 (CONTD.)

Source	SS	df	MS	F	P
R x P	141.86	4	35.32	1.16	-
G x R x P	14.79	4	3.70	0.12	-
G x I x P	90.91	4	22.73	0.75	-
G x R x I x P	66.18	4	16.55	0.54	-
RP x subjects within groups	2923.51	96	30.45		
R x T	5798.82	4	1449.71	55.87	.01
G x R x T	283.37	4	70.84	1.74	-
R x I x T	2104.85	4	526.21	12.96	.01
G x R x I x T	114.62	4	28.66	0.71	-
RT x subjects within groups	3901.70	96	40.64		
P x T	2837.31	4	709.33	24.06	.01
G x P x T	300.41	4	75.10	2.74	.05
I x P x T	781.81	4	195.45	7.12	.01
G x I x P x T	699.76	4	174.94	6.37	.01
PT x subjects within groups	2635.13	96	27.45		
R x P x T	246.23	8	30.78	1.45	-
G x R x P x T	200.79	8	25.10	1.18	-
I x R x P x T	285.89	8	35.74	1.68	-
G x I x R x P x T	40.77	8	5.10	0.24	-
RPT x subjects within groups	4083.86	192	21.27		
Total	18084.84	795			

3.175 On this task, effect of groups is significant in AE, F (1,24) = 8.10, $p < .01$, and VE, F (1,24) = 15.86, $p < .01$ analyses only. For the sighted and blind groups mean AE scores are 12.11° and 14.49°, respectively, and mean VE scores are 4.30° and 7.00°, respectively. These mean scores suggest that reproduction responses of the blind subjects are more variable than their sighted counterpart.

Main effect of informations is significant in all the three error analyses: AE, F (1,24) = 166.50, $p < .01$; VE, F (1,24) = 31.70, $p < .01$; and CE, F (1,24) = 4.66, $p < .05$. For location and distance informations mean AE scores are 7.89° and 18.70°, mean VE scores are 3.74° and 7.56°, and mean CE scores are -1.90° and -4.59°, respectively. This analysis indicates that recall responses for distance targets are more variable than ~~that of~~ location targets. Here, in this curvilinear task both location and distance targets are underestimated, though distance target is more overestimated than the location targets.

Retention interval has been found to be a significantly important factor in all the three error analyses: AE, F (2,48) = 269.08, $p < .01$; VE, F (2,48) = 9.21, $p < .01$; and CE, F (2,48) = 5.55, $p < .01$. For 0 sec, 15 sec and 50 sec retention intervals mean AE scores are 9.37°, 12.87° and 17.66°, mean VE scores are 4.82°, 5.44° and 6.69°, and mean CE scores are -2.33°, 2.88° and 4.52°,

3.176 respectively. These results suggest that variability and underestimation in responses increase with increase in retention intervals.

Main effect of prior activities is also significant for AE, $\underline{F}$ (2,48) = 176.24, $p < .01$, VE, $\underline{F}$ (2,48) = 19.23, $p < .01$; and CE, $\underline{F}$ (2,48) = 3.97, $p < .01$. For 0, 2 and 4 prior activities mean AE scores are 10.17°, 13.90° and 15.83°, mean VE scores are 4.63°, 5.92° and 6.39°, and mean CE scores are -2.20°, -3.93° and -3.60, respectively. These results indicate that variability in recall responses increases with increase in the number of prior activities. Moreover, prior activities were found to increase the underestimation of responses.

Effect of target length is highly significant in the analyses of 3 response measures: AE, $\underline{F}$ (2,48) = 62.54, $p < .01$; VE, $\underline{F}$ (2,48) = 40.76, $p < .01$; and CE, $\underline{F}$ (2,48) = 370.30, $p < .01$. For 30°, 70° and 110° target positions mean AE scores are 10.85°, 11.39° and 17.66°; mean VE scores are 4.76°, 7.97°, and 4.21°, and mean CE scores are 9.06°, -1.75° and -17.04°. In reproduction of the curvilinear task the pattern of VE seems to be different than that of the horizontal task. In reproduction of the curvilinear movement VE has reduced at longer target which like short target is closer to the horizontal base. Other response patterns remain the same as for the horizontal task.

.177 A group x information interaction effect found statistically significant for AE, F (1,24) = 18.66, $p < .01$, and VE, F (1,24) = 6.70, $p < .05$, exhibit a pattern that was also observed in the horizontal task. In reproduction of distance blind subjects show more errors than their sighted counterparts, while opposite trend was observed for location.

Groups x retention intervals x informations interaction effect was significant only for AE, F (2,48) = 3.53, $p < .05$, and indicates that the blind and sighted groups differ in recall of location and distance at different retention intervals.

The most interesting among the second order interactions is a groups x informations x prior activities interaction effect which is highly significant for AE, F (2,48) = 27.70, $p < .01$. Mean scores for this interaction effect are plotted in Fig. 3.5.11. It is noticed that sighted group show proactive inhibition only in reproduction of location targets, while blind subjects show proactive inhibition in reproduction of both location and distance information. This trend of the result supports findings obtained in the horizontal task.

Another important interaction concerning groups x informations x targets is statistically significant in AE, F (2,48) = 6.17, $p < .01$, and CE, F (2,48) = 14.30, $p < .01$,

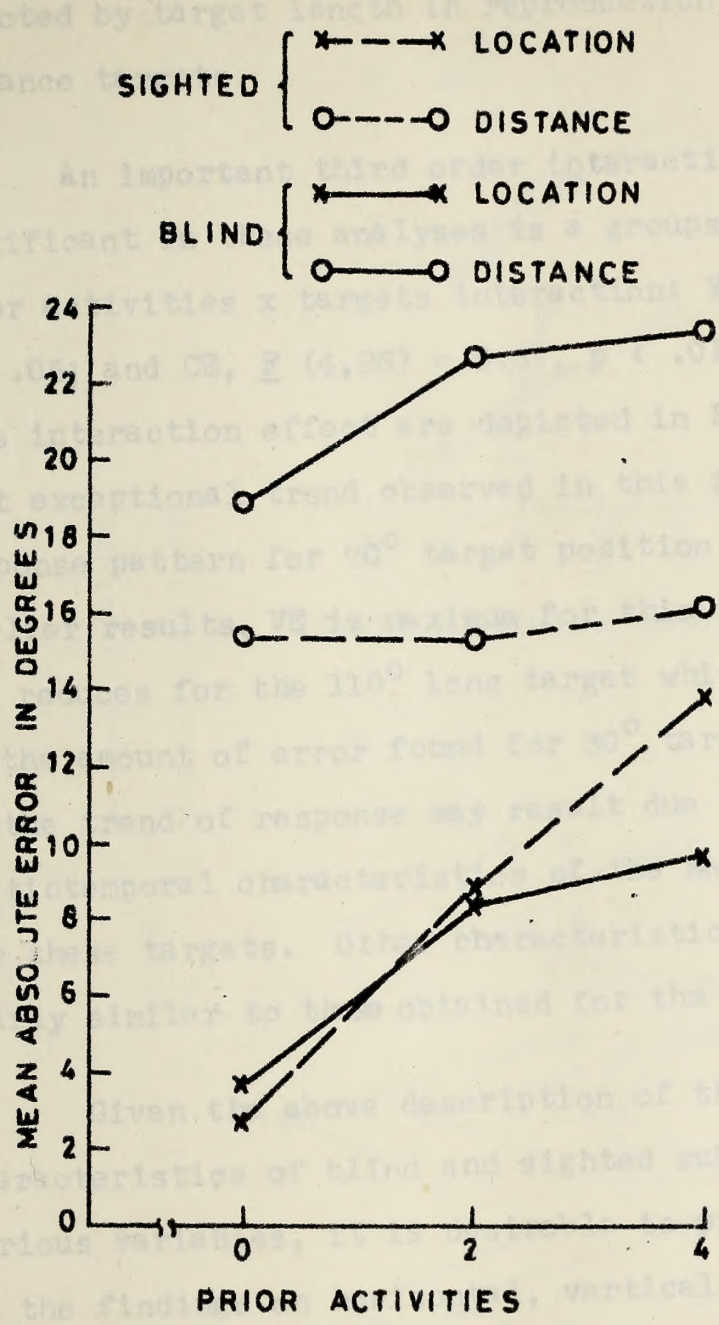


FIG.3.5.11 MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DIFFERENT PRIOR ACTIVITY CONDITIONS

FIG.3.5.11 MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DIFFERENT PRIOR ACTIVITY CONDITIONS

3.178 analyses. These results indicate that groups were differently affected by target length in reproduction of location and distance targets.

An important third order interaction effect found significant in these analyses is a groups x informations x prior activities x targets interaction: VE, $\underline{F}$ (4,96) = 2.53, $p < .05$; and CE, $\underline{F}$ (4,96) = 6.37, $p < .01$. Mean scores for this interaction effect are depicted in Fig.3.5.12. The most exceptional trend observed in this figure is the response pattern for 70° target position. Unlike earlier results, VE is maximum for this target position and reduces for the 110° long target which is very close to the amount of error found for 30° target. This change in the trend of response may result due to the specific spatiotemporal characteristics of the movement required for these targets. Other characteristics of the data remain nearly similar to those obtained for the horizontal task.

Given the above description of the recall characteristics of blind and sighted subjects for the various variables, it is desirable to present a summary of the findings on horizontal, vertical and curvilinear tasks. In general, it is observed that blind and sighted subjects differ in recall of location and distance, implying that location and distance information differ in the requirement of visual reference for their processing.

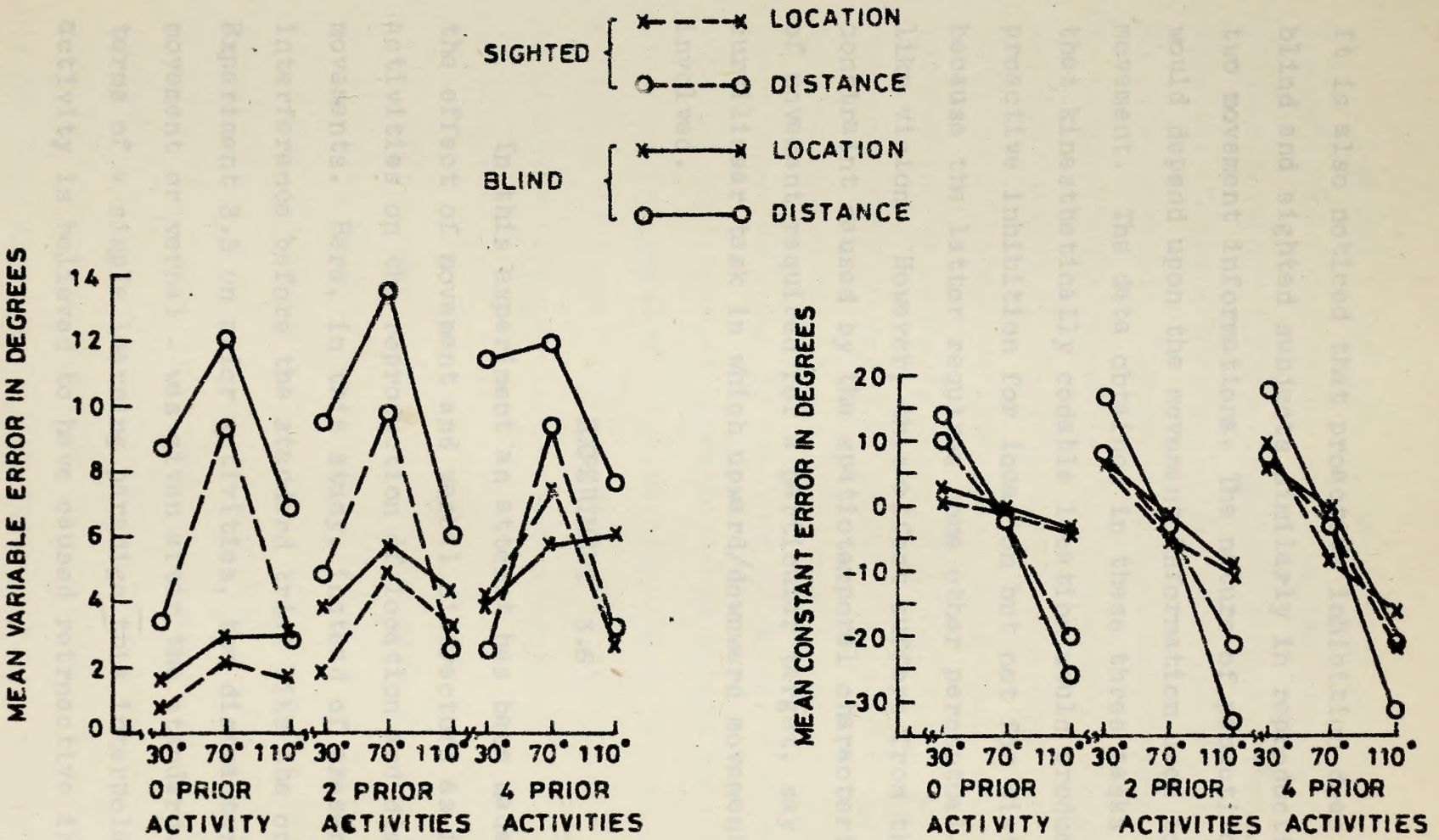


FIG.3.5.12 MEAN VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED SUBJECTS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS AS A FUNCTION OF TARGETS AND PRIOR ACTIVITIES

LOCATION
DISTANCE
SIGHTED
LOCATION
DISTANCE
BLIND
MEAN CONSTANT ERROR IN DEGREES
-30
-20
-10
0
10
20
ACTIVITIES ACTIVITIES
PRIOR 2
PRIOR 4
PRIOR 6
PRIOR 2
PRIOR 4
PRIOR 6
MEAN AVERAGE ERROR IN DEGREES
0
5
10
15
20

3.179 It is also noticed that proactive inhibition does not affect blind and sighted subjects similarly in reproduction of the two movement informations. The nature of proactive inhibition would depend upon the movement information used to code the movement. The data obtained in these three tasks suggest that kinesthetically codable location would produce proactive inhibition for location but not for distance because the latter requires some other perceptual reference like vision. However, this effect suffers from the constraint caused by the spatiotemporal characteristics of movement required for a particular target, say as in a curvilinear task in which upward/downward movement is involved.

EXPERIMENT 3.6

In this experiment an attempt has been made to study the effect of movement and verbal distractors as interpolated activities on the reproduction of location and distance movements. Here, in this study, instead of presenting an interference before the standard trial like the one in Experiment 3.5 on prior activities, the distractor task - movement or verbal - was given after the standard. In terms of a simple learning paradigm this interpolated activity is believed to have caused retroactive inhibition.

3.180 Current literature on the effect of various structural and capacity interference tasks on the reproduction of various movement informations have produced inconclusive results. Laabs (1973) suggested that location information is coded centrally, whereas distance information is coded in terms of motor kinesthetic information. Similar view was put forward in his subsequent researches also (Laabs, 1974, 1976). Diewert (1975) has shown that location information is coded in terms of visual kinesthetic codes, while distance in terms of kinesthetic codes. As stated earlier, the neuro-physiological evidences are against these views as shown in the work of Skoglund (1956) who reported that none of kinesthetic receptors subserve distance information. On the other hand, evidence is gathering in support of the view that vision could serve as nonmotor perceptual reference system for distance information.

Given that blind subjects process the informations mainly with help of kinesthesis, it remains to be seen how blind and sighted subjects would differ in the nature of interference caused by motor and verbal distractors. A major part of this experiment is based on assumptions already described in Experiment 3.5 as in both the experiments motor activity is placed prior to or after the standard trial. At the same time it is also interesting to record how blind and sighted groups attenuate the effect of such interferences

3.181 based on temporal factor, i.e. presented before or after standard movement. Two specific hypotheses are tested in this experiment:

> In location reproduction, blind subjects would be more affected by movement distractor than sighted subjects; whereas distance reproduction would not show this effect so strongly.
>
> In a location task, interpolated backward counting activity would affect both blind and sighted severely, but this would not be so in case of distance.

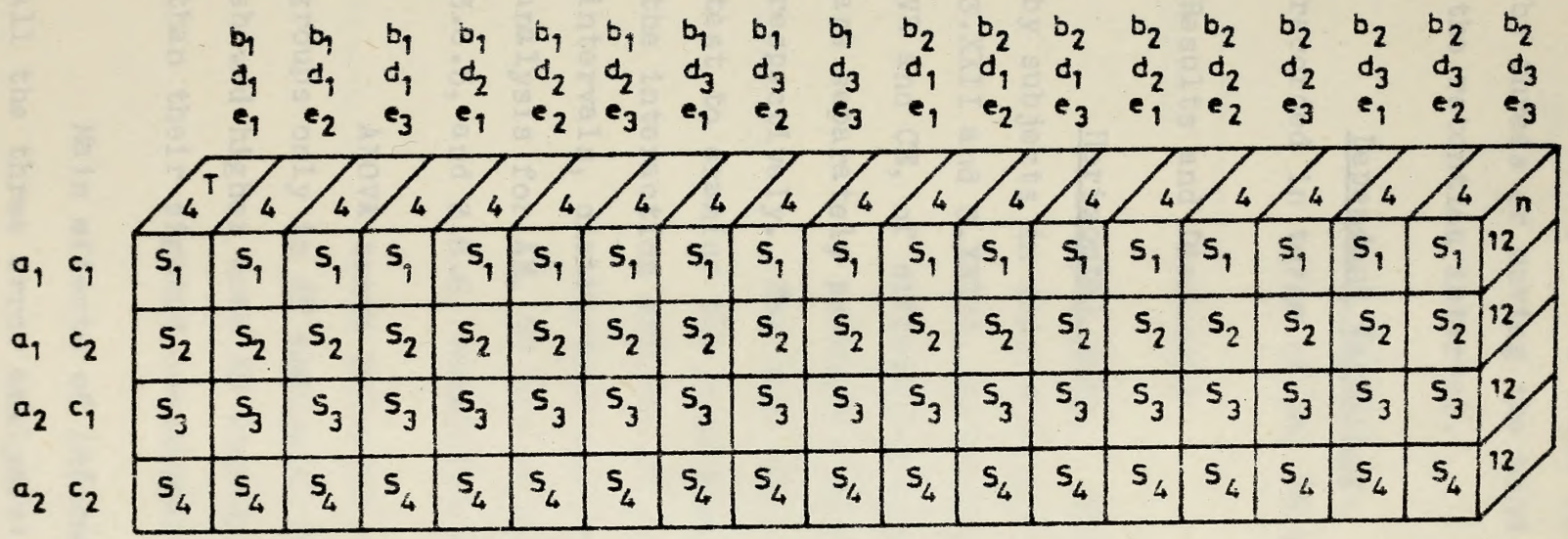
Method and Procedure

Sample. In all, 72 sighted and 72 blind subjects were required for this experiment. The sighted and blind subjects were equally assigned on horizontal, vertical and curvilinear tasks. The age of the subjects ranged between 15 years to 25 years with a mean age of 20 years and 5 months. These blind subjects were selected from hostels and schools for the blind located in Hyderabad city of Andhra Pradesh and Varanasi city of Uttar Pradesh. Sighted subjects were also selected proportionately from the same places. All the subjects in both groups were righthanded males and they were matched for their age, intelligence and educational achievements.

3.182 Apparatus and Materials. The apparatuses used in this experiment were the same Linear Slide and Manual Lever-D as described in Experiment 3.5. Other instruments required were a stop watch and an opaque goggle.

Experimental Design and Procedure. In this experiment a 2 x 2 x 2 x 3 x 3 within subjects factorial design, having groups (sighted or blind), informations (location or distance), retention intervals (20 sec or 90 sec), interpolated activities (control, backward counting or movement) and targets (10 cm/30°, 20 cm/70° or 30 cm/110°), was employed for each of the three tasks (Fig. 3.6.1). A fresh set of 12 subjects was assigned for sighted location, sighted distance, blind location and blind distance subgroups. Four repeated measures were taken on the remaining three variables to make 18 experimental conditions. In all, each subject received 72 trials. These trials were randomly conducted in 4 sessions divided into equal number. An intertrial interval of 1 minute was given.

No change in the general procedure was made and it was the same as reported in the previous experiments. The two informations, viz. location, and distance, were isolated using a similar procedure to that of Hermelin and O'Connor (1975).



a-GROUPS
1) SIGHTED
2) BLIND

b-RETENTION INTERVALS
1) 20 Sec
2) 90 Sec

c—INFORMATIONS
1) LOCATION
2) DISTANCE

d—DISTRACTORS
1) UNFILLED
2) BACKWARD COUNTING
3) MOVEMENT

e — TARGETS
1) 10cm/30°- SHORT
2) 20cm/70°- MEDIUM
3) 30cm/110°- LONG

FIG.3.6.1 DESIGN OF EXPERIMENT 3.6

3.183 Interpolated tasks involved either counting backward by threes or moving the hand in a circle for the period of the retention interval.

Dependent Variables. Reproduction errors were recorded in terms of AE, VE and CE.

Results and Discussion

Horizontal Task. Raw AE, VE and CE scores obtained by subjects in this task are reported in Appendices 3.XXI, 3.XXII and 3.XXIII, respectively. Means and S.D. of AE, VE and CE, of different groups under all treatment levels are separately presented in Tables 3.6.1, 3.6.2 and 3.6.3, respectively. The data were further subjected to an ANOVA test to examine the significance of the main effects and the interaction effects of groups, informations, retention intervals, distractors and targets. A summary of this analysis for AE, VE and CE data is reported in Tables 3.6.4, 3.6.5, and 3.6.6, respectively.

ANOVA tests revealed significant main effect of groups only in AE analysis, F (1,44) = 8.88, $p < .01$. It showed higher mean AE committed by the blind group (3.84 cm) than their sighted counterparts (3.34 cm).

Main effects of informations was found significant in all the three error analyses: AE, F (1,44) = 321.06, $p < .01$,

3.184

TABLE 3.6.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	R (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.70 (0.33)	2.93 (0.50)	0.73 (0.30)	4.26 (2.37)
		20	0.99 (0.46)	3.81 (0.93)	1.11 (0.31)	3.00 (1.18)
		30	1.59 (0.30)	5.48 (1.40)	1.57 (0.70)	7.18 (2.14)
	90	10	0.76 (0.42)	4.27 (1.23)	0.79 (0.21)	5.79 (2.76)
		20	1.10 (1.36)	5.14 (0.90)	1.30 (0.41)	4.00 (1.31)
		30	1.96 (0.53)	7.80 (2.59)	1.68 (0.79)	9.30 (2.20)
Counting	20	10	1.64 (0.42)	3.06 (0.52)	1.58 (0.20)	4.54 (1.77)
		20	1.78 (0.46)	3.75 (0.87)	1.84 (0.44)	3.01 (1.02)
		30	2.37 (0.55)	6.14 (1.28)	2.72 (0.99)	6.63 (2.13)
	90	10	2.50 (0.98)	4.03 (1.39)	3.68 (1.19)	5.71 (2.79)
		20	2.35 (0.77)	4.68 (1.24)	3.34 (1.24)	4.20 (1.61)
		30	3.21 (0.71)	7.29 (2.26)	3.99 (0.90)	7.97 (2.09)
Movement	20	10	1.29 (0.52)	2.96 (0.61)	2.26 (0.93)	4.50 (2.28)
		20	1.69 (0.45)	3.81 (1.30)	2.56 (0.53)	3.75 (1.22)
		30	2.25 (0.42)	6.11 (1.06)	2.72 (0.90)	5.81 (2.33)
	90	10	1.83 (0.70)	4.16 (1.44)	3.05 (1.32)	6.29 (1.99)
		20	2.14 (0.84)	4.80 (0.78)	3.55 (1.11)	3.41 (1.47)
		30	2.91 (0.66)	7.00 (1.80)	3.58 (0.72)	6.83 (2.92)

TABLE 3.6.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AS SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER DISTANCE (D), RESPONSE INTERVAL (R) AND TARGET (T) CONDITIONS

D	R (sec)	T (cm)	SIGHTED LOCATION	SIGHTED DISTANCE	BLIND LOCATION	BLIND DISTANCE
Control	20	10	0.70 (0.33)	2.93 (0.80)	0.72 (0.30)	1.06 (6.37)
		20	0.99 (0.46)	3.81 (0.93)	1.11 (0.31)	3.00 (1.18)
		30	1.89 (0.20)	8.48 (1.10)	1.57 (0.70)	7.32 (9.14)
	90	10	0.74 (0.42)	4.27 (1.29)	0.72 (0.21)	5.70 (5.79)
		20	1.10 (1.36)	8.13 (0.90)	1.30 (0.41)	4.00 (1.31)
		30	1.96 (0.85)	7.80 (3.80)	1.86 (0.78)	8.39 (2.27)
Counting	20	10	1.64 (0.42)	5.06 (0.83)	1.82 (0.30)	3.64 (1.77)
		20	1.78 (0.46)	3.73 (0.89)	1.84 (0.44)	3.01 (1.02)
		30	2.37 (0.83)	9.13 (1.28)	2.10 (0.70)	5.09 (8.19)
	90	10	8.80 (0.98)	9.05 (1.39)	3.66 (1.19)	8.41 (2.36)
		20	2.73 (0.77)	4.98 (1.89)	2.31 (1.84)	3.36 (1.81)
		30	3.21 (0.71)	7.85 (5.85)	3.20 (0.00)	7.06 (9.06)
Movement	20	10	1.38 (0.82)	8.86 (0.81)	8.36 (0.87)	8.60 (8.58)
		20	1.48 (0.48)	8.21 (1.30)	8.66 (0.54)	3.76 (1.82)
		30	2.38 (0.13)	8.11 (1.05)	2.30 (0.70)	3.21 (2.04)
	90	10	1.82 (0.70)	4.16 (1.41)	1.68 (1.38)	8.08 (1.38)
		20	2.14 (0.84)	3.80 (0.72)	2.82 (1.11)	3.41 (1.47)
		30	2.81 (0.66)	7.00 (1.80)	3.00 (0.75)	8.80 (2.88)

3.185

TABLE 3.6.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORE (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

IA	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.72 (0.36)	1.96 (0.88)	0.36 (0.16)	2.13 (1.89)
		20	1.00 (0.43)	2.26 (1.32)	0.89 (0.42)	2.13 (1.01)
		30	1.51 (0.41)	3.28 (1.98)	1.04 (0.42)	1.65 (0.79)
	90	10	0.60 (0.41)	1.91 (1.28)	0.54 (0.24)	2.06 (0.65)
		20	0.96 (0.50)	3.41 (1.78)	1.10 (0.48)	3.33 (1.79)
		30	1.49 (0.84)	2.30 (1.43)	1.42 (0.71)	2.63 (1.60)
Counting	20	10	1.17 (0.57)	1.66 (1.07)	0.75 (0.46)	2.01 (0.80)
		20	1.37 (0.68)	2.42 (1.25)	1.22 (0.57)	2.31 (0.94)
		30	1.82 (0.72)	2.54 (2.03)	2.19 (1.04)	2.07 (0.97)
	90	10	1.88 (0.70)	1.70 (1.26)	1.69 (0.71)	3.67 (2.59)
		20	1.54 (1.02)	4.42 (1.14)	2.46 (1.25)	4.07 (1.84)
		30	2.23 (1.00)	1.90 (1.43)	2.24 (1.39)	1.70 (0.74)
Experiment	20	10	0.73 (0.47)	1.77 (1.21)	1.19 (0.79)	2.01 (1.02)
		20	1.35 (0.55)	3.04 (1.11)	2.09 (0.87)	3.42 (1.44)
		30	1.98 (0.49)	2.72 (1.84)	2.19 (0.97)	2.82 (1.54)
	90	10	1.44 (0.65)	1.45 (1.01)	1.10 (0.44)	2.56 (1.68)
		20	1.60 (0.95)	3.39 (1.68)	2.19 (1.05)	3.04 (1.12)
		30	2.52 (0.86)	2.68 (1.92)	2.69 (1.16)	2.57 (1.10)

TABLE 3.6.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORE (IN CM) OF SLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D', RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

IA	RI (sec)	T (cm)	SIGHTED LOCATION	SIGHTED DISTANCE	BLIND LOCATION	BLIND DISTANCE
Control	20	10	0.72 (0.36)	1.86 (0.88)	0.36 (0.16)	2.32 (1.89)
		20	1.00 (0.43)	2.86 (1.39)	0.88 (0.42)	2.12 (1.01)
		30	1.51 (0.41)	3.38 (1.88)	1.04 (0.42)	1.85 (0.79)
	90	10	0.60 (0.41)	1.91 (1.88)	0.54 (0.24)	2.06 (0.65)
		20	0.96 (0.50)	3.42 (1.76)	1.10 (0.48)	3.30 (1.70)
		30	1.49 (0.84)	3.30 (1.43)	1.48 (0.71)	3.65 (1.60)
Counting	20	10	1.17 (0.87)	1.56 (1.07)	0.76 (0.46)	2.07 (0.80)
		20	1.37 (0.68)	3.42 (1.85)	1.32 (0.97)	3.11 (0.96)
		30	1.82 (0.72)	3.64 (2.03)	1.48 (1.04)	2.87 (0.89)
	90	10	1.88 (0.70)	1.90 (1.86)	1.69 (0.71)	3.57 (2.30)
		20	1.84 (1.02)	4.12 (1.14)	2.46 (1.85)	4.07 (1.84)
		30	2.23 (1.00)	3.90 (1.43)	2.84 (1.39)	3.70 (0.74)
Experiment	20	10	0.73 (0.49)	1.77 (1.21)	1.19 (0.76)	3.01 (1.09)
		20	1.35 (0.35)	3.04 (0.11)	2.00 (0.87)	3.42 (1.44)
		30	1.55 (0.49)	2.76 (1.84)	2.10 (0.97)	3.82 (1.84)
	90	10	1.44 (0.85)	1.45 (1.01)	1.10 (0.44)	2.96 (1.89)
		20	1.60 (0.96)	3.39 (1.88)	2.10 (1.03)	3.04 (1.19)
		30	2.32 (0.86)	2.88 (1.89)	2.68 (1.16)	3.97 (1.10)

.186

TABLE 3.6.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF HORIZONTAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

IA	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.32 (0.39)	1.60 (2.05)	0.38 (0.12)	3.63 (2.29)
		20	0.02 (0.55)	-0.04 (2.78)	0.47 (0.23)	-0.39 (4.72)
		30	-0.31 (0.97)	-3.24 (3.88)	0.08 (1.08)	-6.31 (3.71)
	90	10	0.10 (0.54)	-1.75 (5.20)	0.44 (0.13)	7.36 (3.18)
		20	0.27 (0.81)	-1.08 (3.10)	0.31 (0.43)	-0.75 (7.06)
		30	-0.67 (1.21)	-7.79 (1.26)	0.12 (1.32)	-11.25 (3.37)
Counting	20	10	1.34 (1.03)	1.89 (1.21)	1.73 (0.90)	3.21 (2.73)
		20	0.61 (1.09)	-0.97 (1.94)	1.83 (0.76)	-0.55 (4.29)
		30	-1.43 (1.75)	-5.50 (0.85)	-0.29 (1.41)	-6.02 (4.13)
	90	10	1.75 (1.31)	2.59 (1.86)	3.00 (0.89)	5.82 (4.24)
		20	-0.23 (2.10)	-1.62 (2.82)	2.43 (1.33)	-0.70 (-6.38)
		30	-1.97 (2.18)	-6.34 (3.07)	-1.05 (2.25)	-8.22 (-4.68)
Movement	20	10	0.54 (0.89)	2.10 (1.31)	1.80 (0.73)	3.70 (3.08)
		20	0.00 (1.26)	0.37 (1.60)	2.02 (1.44)	-0.35 (5.30)
		30	-0.44 (2.38)	-4.83 (1.50)	0.23 (2.17)	-5.84 (4.22)
	90	10	1.60 (1.20)	3.68 (2.06)	2.29 (1.13)	5.51 (3.85)
		20	0.76 (1.66)	1.17 (3.11)	3.10 (1.21)	-0.89 (4.67)
		30	-0.94 (2.06)	-6.71 (2.23)	-0.10 (2.46)	-8.06 (6.41)

3.187

TABLE 3.6.4

SUMMARY OF ANOVA OBTAINED FOR AE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	2275.85	47			
Groups (G)	54.03	1	54.03	8.88	.01
Informations (I)	1954.03	1	1954.03	321.06	.01
G x I	0.00	1	0.00	0.00	-
Subjects within groups	267.79	44	6.09		
Within subjects	2559.68	816			
Retention Intervals (R)	196.53	1	196.53	77.19	.01
G x R	1.64	1	1.64	0.64	-
I x R	15.29	1	15.29	6.00	.05
G x I x R	2.34	1	2.34	0.92	-
R x subjects within groups	112.03	44	2.55		
Distractors (D)	61.53	2	30.76	24.56	.01
G x D	2.59	2	1.29	1.03	-
I x D	118.66	2	59.33	47.37	.01
G x I x D	15.55	2	7.78	6.28	.01
D x subjects within groups	110.21	88	1.25		
Targets (T)	585.21	2	292.77	57.83	.01
G x T	48.79	2	24.39	4.82	.05
I x T	231.18	2	115.59	22.83	.01
G x I x T	56.17	2	28.09	5.55	.01
T x subjects within groups	445.50	88	5.06		

TABLE 3.6.4

SUMMARY OF ANOVA OBTAINED FOR AS SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	2276.85	47			
Groups (G)	84.03	1	84.03	6.88	.01
Informations (I)	1954.03	1	1954.03	321.06	.01
G x I	0.00	1	0.00	0.00	-
Subjects within groups	267.79	44	6.09		
Within subjects	2589.68	816			
Retention Intervals (R)	196.53	1	196.53	72.19	.01
G x R	1.64	1	1.64	0.64	-
I x R	15.29	1	15.29	6.00	.05
G x I x R	2.34	1	2.34	0.92	-
R x subjects within groups	112.03	44	2.55		
Distractors (D)	61.85	2	30.76	24.56	.01
G x D	2.59	2	1.29	1.03	-
I x D	118.66	2	59.33	47.37	.01
G x I x D	15.55	2	7.78	6.28	.01
D x subjects within groups	110.21	88	1.26		
Targets (T)	588.21	2	294.11	37.83	.01
G x T	48.78	2	24.39	4.82	.05
I x T	231.18	2	115.59	22.83	.01
G x I x T	56.17	2	28.09	5.55	.01
T x subjects within groups	445.50	88	5.06		

3.188

TABLE 3.6.4 (CONTD.)

Source	SS	df	MS	F	p
R x D	4.16	2	2.31	3.06	-
G x R x D	3.89	2	1.95	2.88	-
I x R x D	23.62	2	11.81	18.66	.01
G x I x R x D	0.83	2	0.41	0.55	-
RD x subjects within groups	66.38	88	0.75		
R x T	4.70	2	2.35	2.55	-
G x R x T	1.59	2	0.79	0.86	-
I x R x T	3.20	2	1.60	1.74	-
G x I x R x T	2.19	2	1.10	1.20	-
RI x subjects within groups	80.66	88	0.92		
D x T	14.71	4	3.68	3.32	.05
G x D x T	12.54	4	3.13	3.25	.05
I x D x T	7.79	4	1.95	2.02	-
G x I x D x T	8.45	4	2.11	2.19	-
DT x subjects within groups	169.54	176	0.96		
R x D x T	4.31	4	1.08	1.38	-
G x R x D x T	1.25	4	0.31	0.40	-
I x R x D x T	5.36	4	1.34	1.72	-
G x I x R x D x T	3.47	4	0.87	1.11	-
RDT x subjects within groups	137.00	176	0.78		
Total	4835.53	863			

3.189

TABLE 3.6.5

SUMMARY OF ANOVA OBTAINED FOR VE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	391.36	47			
Groups (G)	1.26	1	1.20	0.36	-
Informations (I)	237.95	1	237.95	68.81	.01
G x I	0.00	1	0.00	0.00	-
Subjects within groups	152.15	44	3.46		
Within subjects	1162.78	816			
Retention Intervals (R)	26.73	1	26.73	21.96	.01
G x R	3.24	1	3.24	2.66	-
I x R	0.03	1	0.03	0.02	-
G x I x R	1.25	1	1.25	1.03	-
R x subjects within groups	53.56	44	1.22		
Distractors (D)	41.54	2	20.77	18.13	.01
G x D	7.54	2	3.77	3.29	.05
I x D	17.30	2	8.65	7.55	.01
G x I x D	0.40	2	0.20	0.17	-
D x subjects within groups	100.83	88	1.15		
Targets (T)	93.54	2	46.77	24.48	.01
G x T	6.00	2	3.00	1.57	-
I x T	48.57	2	24.28	12.71	.01
G x I x T	18.46	2	9.23	4.83	.05
T x subjects within groups	168.14	88	1.91		

.190

TABLE 3.6.5 (CONTD.)

Source	SS	df	MS	F	p
R x D	10.42	2	5.21	3.95	.05
G x R x D	4.87	2	2.44	1.85	-
I x R x D	4.06	2	2.03	1.54	-
G x R x R x D	0.00	2	0.00		
RD x subjects within groups	116.06	88	1.32		
R x T	13.94	2	6.97	7.58	.01
G x R x T	1.14	2	0.57	0.62	-
I x R x T	13.66	2	6.83	7.42	.01
G x I x R x T	6.83	2	3.42	3.72	.05
RT x subjects within groups	81.36	88	0.92		
D x T	14.56	4	3.64	3.94	.01
G x D x T	1.02	4	0.25	0.28	-
I x D x T	6.69	4	1.67	1.81	-
G x I x D x T	5.22	4	1.30	1.41	-
DT x subjects within groups	162.67	176	0.92		
R x D x T	17.56	4	4.39	3.90	.01
G x R x D x T	6.45	4	1.61	1.43	-
I x R x D x T	4.22	4	1.06	0.94	-
G x I x R x D x T	6.82	4	1.71	1.52	-
RDT x subjects within groups	198.10	176	1.31		
Total	1654.14	863			

3.191

TABLE 3.6.6

SUMMARY OF ANOVA OBTAINED FOR CE SCORES OF HORIZONTAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	1514.37	47			
Groups (G)	16.78	1	16.78	0.72	-
Informations (I)	454.03	1	454.03	19.51	.01
G x I	19.61	1	19.61	0.84	-
Subjects within groups	1023.93	44	23.27		
Within subjects	11106.51	816			
Retention Intervals (R)	0.93	1	0.93	0.38	-
G x R	5.15	1	5.65	2.30	-
I x R	4.27	1	4.27	1.74	-
G x I x R	0.09	1	0.09	0.04	-
R x subjects within groups	108.05	44	2.46		
Distractors (D)	189.57	2	94.78	26.77	.01
G x D	7.06	2	3.53	1.00	-
I x D	16.09	2	8.04	2.27	-
G x I x D	3.39	2	1.69	0.48	-
D x subjects within groups	311.56	88	3.54		
Targets (T)	4879.47	2	2439.74	219.61	.01
G x T	297.29	2	148.65	13.38	.01
I x T	2465.31	2	1232.65	110.96	.01
G x I x T	51.42	2	25.71	2.31	-
T x subjects within groups	977.62	88	11.11		

.192

TABLE 3.6.6 (CONTD.)

Source	SS	df	MS	F	p
R x D	6.37	2	3.19	0.89	-
G x R x D	1.71	2	0.85	0.24	-
I x R x D	1.94	2	0.97	0.27	-
G x I x R x D	5.59	2	2.79	0.78	-
RD x subjects within groups	313.69	88	3.56		
R x T	129.33	2	64.56	26.83	.01
G x R x T	2.07	2	1.03	2.93	-
I x R x T	61.43	2	30.72	12.75	.01
G x I x R x T	26.88	2	13.44	5.58	.01
RT x subjects within groups	212.14	88	2.41		
D x T	42.06	4	10.52	4.90	.01
G x D x T	3.16	4	0.79	0.37	-
I x D x T	58.94	4	14.74	6.36	.01
G x I x D x T	33.08	4	8.27	3.85	.01
DT x subjects within groups	378.03	176	2.15		
R x D x T	3.72	4	0.93	0.36	-
G x R x D x T	9.65	4	2.41	0.94	-
I x R x D x T	17.52	4	4.38	1.70	-
G x I x R x D x T	27.84	4	6.96	2.70	.05
RDT x subjects within groups	453.58	176	2.58		
Total	12620.88	863			

TABLE 3.6.8 (CONTD.)

Source	SS	df	MS	F	P
R x D	6.37	2	3.19	0.89	-
G x R x D	1.71	2	0.85	0.24	-
I x R x D	1.94	2	0.97	0.27	-
G x I x R x D	5.58	2	2.79	0.78	-
RD x subjects within groups	313.20	88	3.56		
R x T	129.23	2	64.62	36.03	.01
G x R x T	2.07	2	1.03	0.57	-
I x R x T	61.12	2	30.56	17.04	.01
G x I x R x T	20.88	2	10.44	5.82	.01
RT x subjects within groups	212.14	88	2.41		
D x T	42.06	4	10.52	4.80	.01
G x D x T	3.16	4	0.79	0.36	-
I x D x T	58.04	4	14.51	6.62	.01
G x I x D x T	33.08	4	8.27	3.77	.01
DT x subjects within groups	378.03	176	2.15		
R x D x T	3.72	4	0.93	0.42	-
G x R x D x T	0.86	4	0.21	0.09	-
I x R x D x T	14.82	4	3.70	1.70	-
G x I x R x D x T	27.84	4	6.96	3.18	.05
RDT x subjects within groups	385.82	176	2.19		
Total	1820.86	863			

.193 VE, F (1,44) = 68.81, $p < .01$, and CE, F (1,44) = 19.51, $p < .01$. Location and distance conditions exhibit mean AE scores of 2.78 cm and 5.10 cm; mean VE scores of 1.48 cm and 2.53 cm; and mean CE scores of 0.58 cm and -0.87 cm, respectively. This effect has been seen consistently in Experiments 3.2, 3.3, 3.4 and 3.5 reported earlier and also in several previous researches (Hermelin and O'Connor, 1975; Laabs, 1973).

Main effect of retention intervals is significant for AE, F (1,44) = 77.19, $p < .01$ and VE, F (1,44) = 21.96, $p < .01$, analyses. Retention intervals of 20 sec and 90 sec reveal mean AE scores of 3.11 cm and 4.07 cm and mean VE scores of 1.83 cm and 2.18 cm, respectively. It appears that both AE and VE increase with increase in delay of recall.

Main effect of distractors is significant in all the three error analyses: AE, F (2,88) = 24.56, $p < .01$, VE, F (2,88) = 18.13, $p < .01$, and CE, F (2,88) = 26.77, $p < .01$. The unfilled, verbal and movement distractor conditions reveal mean AE scores of 3.22 cm, 3.83 cm and 3.72 cm; mean VE scores of 1.69 cm, 2.12 cm and 2.19 cm; and mean CE scores of -0.70 cm, -0.19 cm and 0.45 cm, respectively. Both verbal and movement distractors cause deterioration in recall accuracy.

Main effects of targets is also significant in all the three error analyses: AE, F (2,88) = 57.83, $p < .01$; VE,

3.194 $F(2,88) = 24.48$, $p < .01$, and CE, $F(2,88) = 219.61$, $p < .01$. Targets of 10 cm, 20 cm and 30 cm exhibited mean AE scores of 3.06 cm, 2.96 cm and 4.75 cm; mean VE scores of 1.54 cm, 2.29 cm and 2.17 cm; and mean CE scores of 2.49 cm, 0.34 cm, and -3.27 cm, respectively. A marked depression in errors is noted on 20 cm target but long (30 cm) target reveals higher error than the short (10 cm).

Among the first order interactions a groups x distractors interaction effect was found significant in VE analysis: ($F(2,88) = 3.29$, $p < .05$). It revealed that the blind and sighted groups mainly differ in movement distractor condition, the blind group being more affected than the sighted. This finding may be interpreted as showing high reliance of blind subjects on their kinesthetic modality in sharp contrast to the sighted who tend to seek support from their visual reference.

Another first order interaction effect of crucial importance is an informations x distractor interactions which is significant in AE, $F(2,88) = 47.37$, $p < .01$, and VE, $F(2,88) = 7.55$, $p < .01$, analyses. Both AE and VE data support the contention that both verbal and movement distractors were causing retroactive inhibition for location reproduction but had little effect on distance reproduction. This interaction effect reveals that location information depended on kinesthetic modality and need attention for its processing. The distance information, on the other hand,

3.195 appear to be less dependent on kinesthetic modality and attention demand.

A groups x targets interaction effect was significant in AE, F (2,88) = 4.82, $p < .05$, and CE, F (2,88) = 13.38, $p < .01$. This interaction effect revealed that the blind and sighted subjects differ only on short and long targets, the blind subjects being poorer than those in the sighted group. On the contrary, on middle targets blind subjects were better than the sighted subjects. CE analysis revealed that on short targets the blind subjects show more overestimation than the sighted subjects, while on long targets the blind subjects show more underestimation than the sighted subjects. This finding is similar to that obtained in Experiment 3.5.

Among the second order interaction effects the most crucial one is a groups x informations x distractors interaction effect which is significant in AE analysis, F (2,88) = 6.21, $p < .01$. Mean scores for this interaction effect are plotted in Fig. 3.6.2 which shows that in location reproduction both counting and movement distractors show a stronger effect on the blind group than the sighted group. Irrespective of the distractor conditions, in reproduction of distance the blind subjects show higher AE than the sighted subjects, while both groups remain unaffected by distractors employed in this experiment. This finding provides further support to the results obtained in Experiment 3.5.

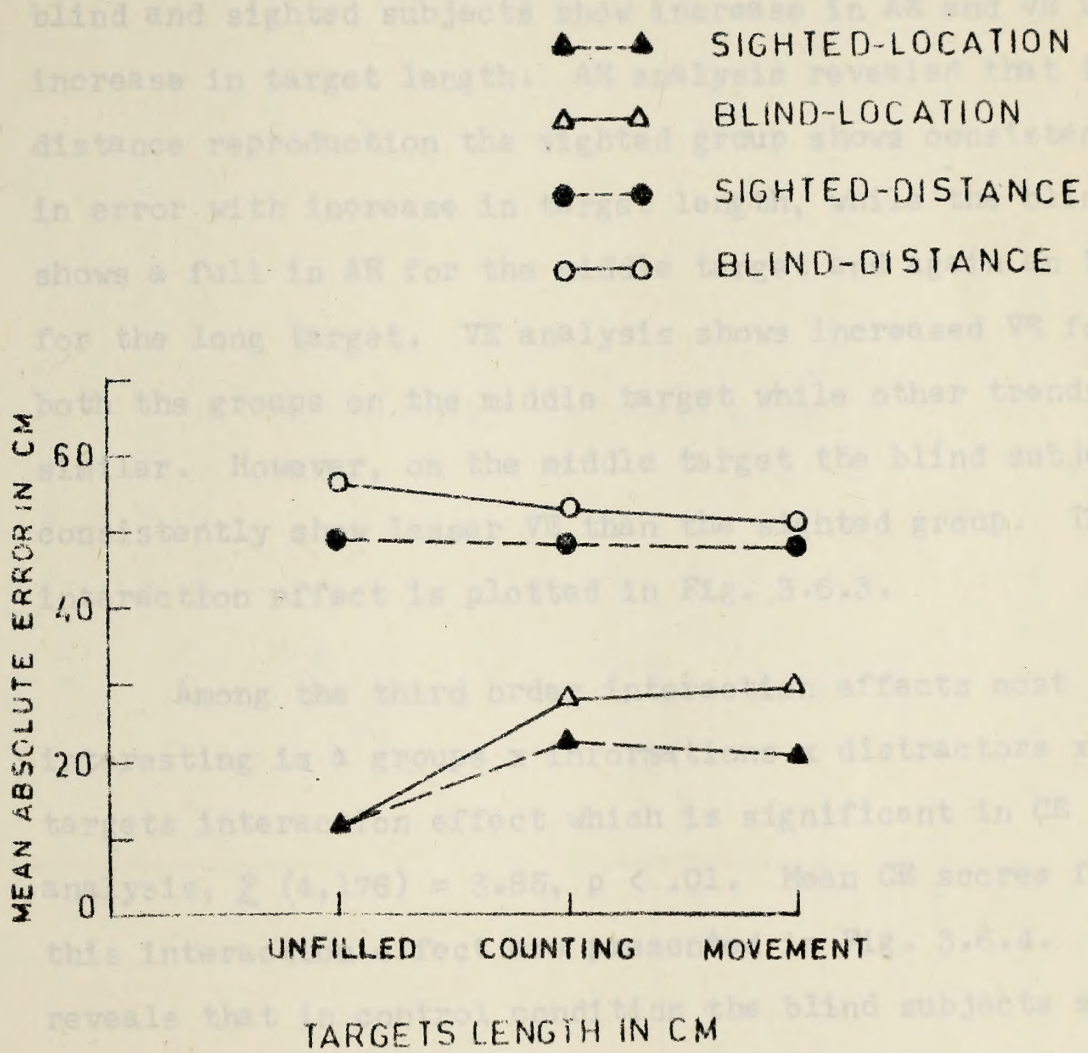


FIG. 3.6.2 MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED SUBJECTS IN HORIZONTAL TASK AS A FUNCTION OF INFORMATION AND DISRACTORS

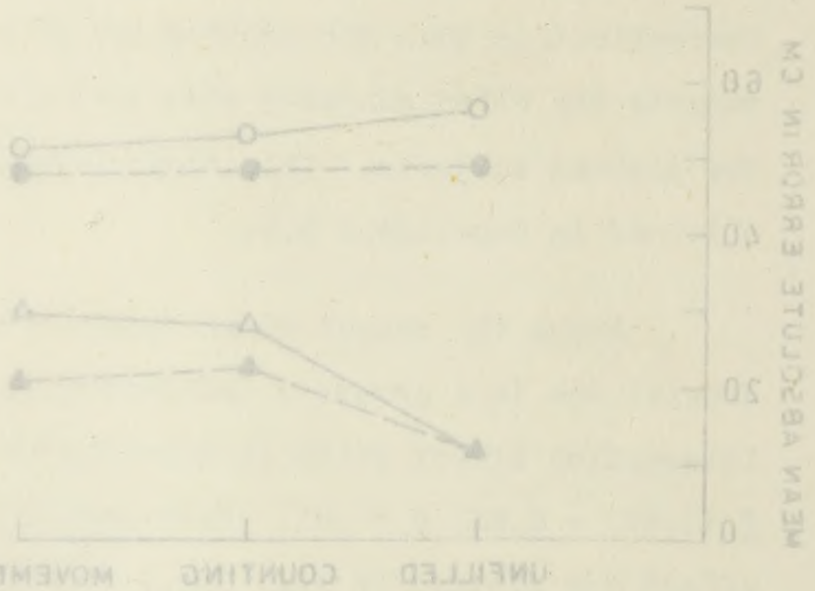


FIG. 3.6.2 MEAN ABSOLUTE ERRORS OF BLIND AND SIGHTED SUBJECTS IN HORIZONTAL TASK AS A FUNCTION OF INFORMATION AND DISTRACTORS

.196 Another interesting second order interaction effect found significant is a groups x informations x targets interaction effect: AE, F (2,88) = 5.55, $p < .01$, and VE, F (2,88) = 4.83, $p < .05$. In location reproduction both blind and sighted subjects show increase in AE and VE with increase in target length. AE analysis revealed that in distance reproduction the sighted group shows consistent increase in error with increase in target length, while the blind group shows a full in AE for the middle target and again an increase for the long target. VE analysis shows increased VE for both the groups on the middle target while other trends remain similar. However, on the middle target the blind subjects consistently show lesser VE than the sighted group. This interaction effect is plotted in Fig. 3.6.3.

Among the third order interaction effects most interesting is a groups x informations x distractors x targets interaction effect which is significant in CE analysis, F (4,176) = 3.85, $p < .01$. Mean CE scores for this interaction effect are presented in Fig. 3.6.4. It reveals that in control condition the blind subjects show a slightly stronger tendency to overestimate short and middle targets in sharp contrast to the sighted group, while on long location targets both groups show a tendency to underestimate. In distance reproduction under control condition blind subjects show a stronger tendency to underestimate long targets and overestimate short targets as compared to the sighted subjects.

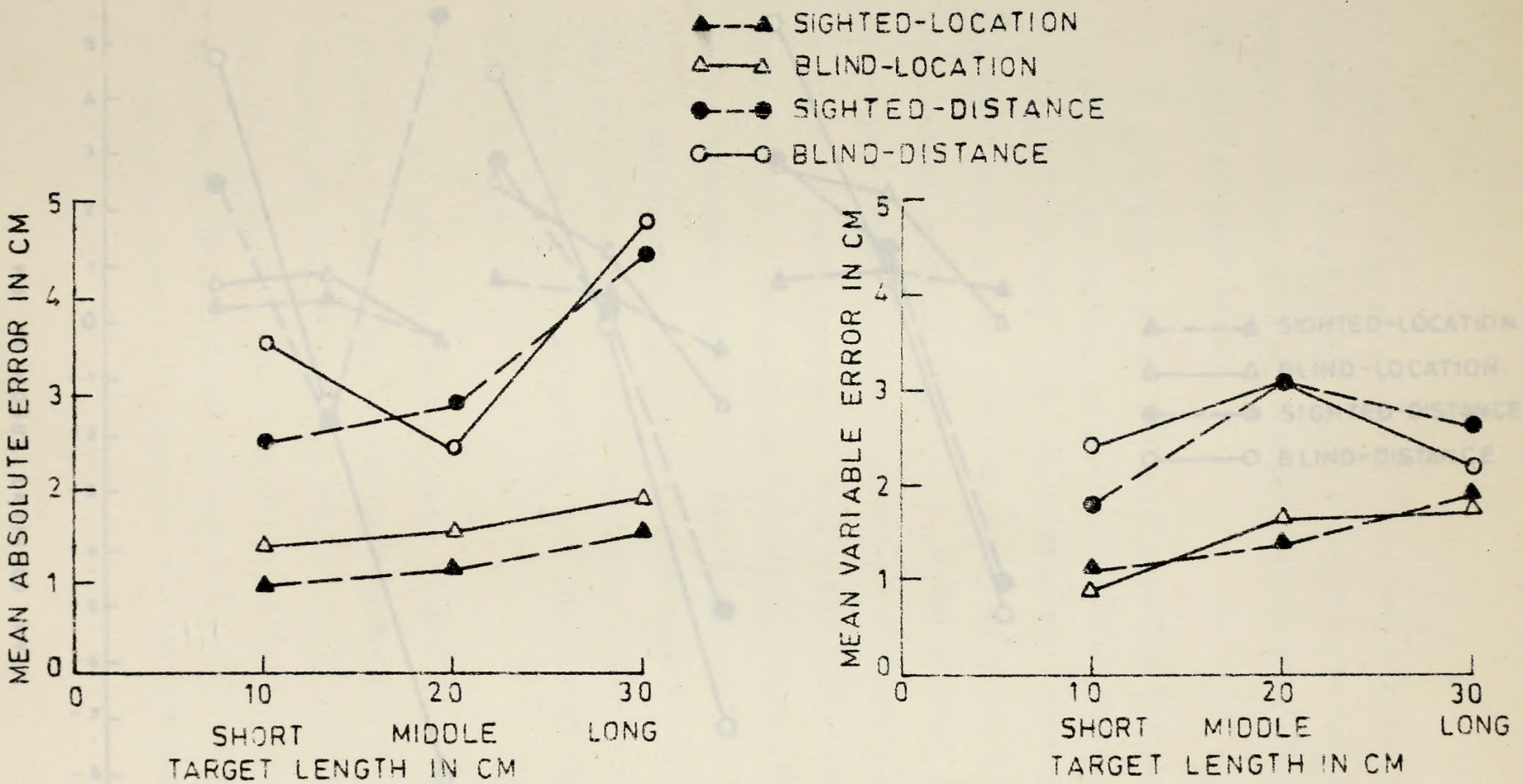
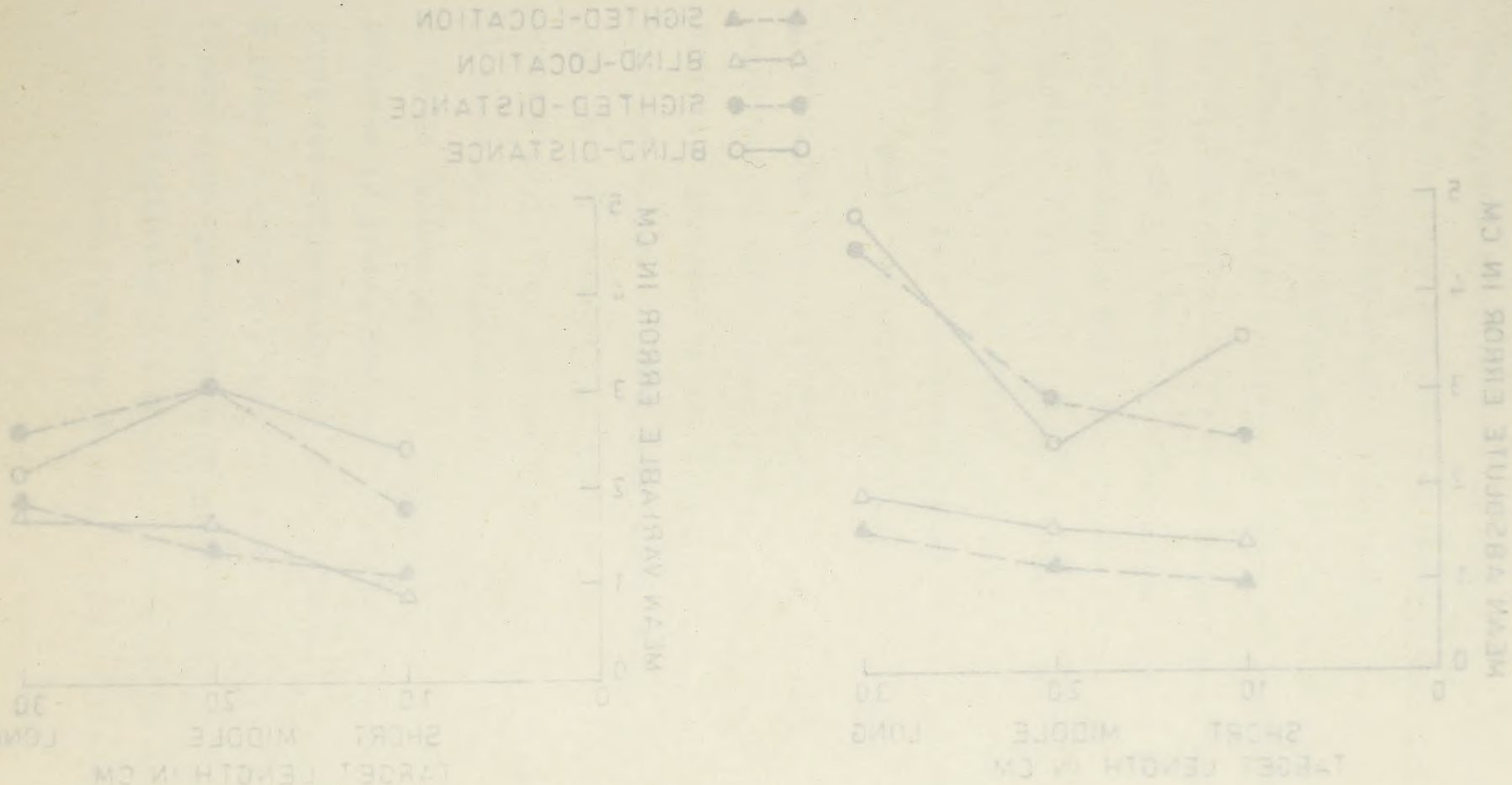


FIG.3.6.3 MEAN ABSOLUTE AND VARIABLE ERRORS OF BLIND AND SIGHTED SUBJECTS IN HORIZONTAL TASK AS A FUNCTION OF RETENTION INTERVALS AND TARGETS.


SIGHTED-LOCATION
BLIND-LOCATION
SIGHTED-DISTANCE
BLIND-DISTANCE
MEAN VARIABLE ERROR IN CM
MEAN ABSOLUTE ERROR IN CM
SHORT
MIDDLE
LONG
TARGET LENGTH IN CM

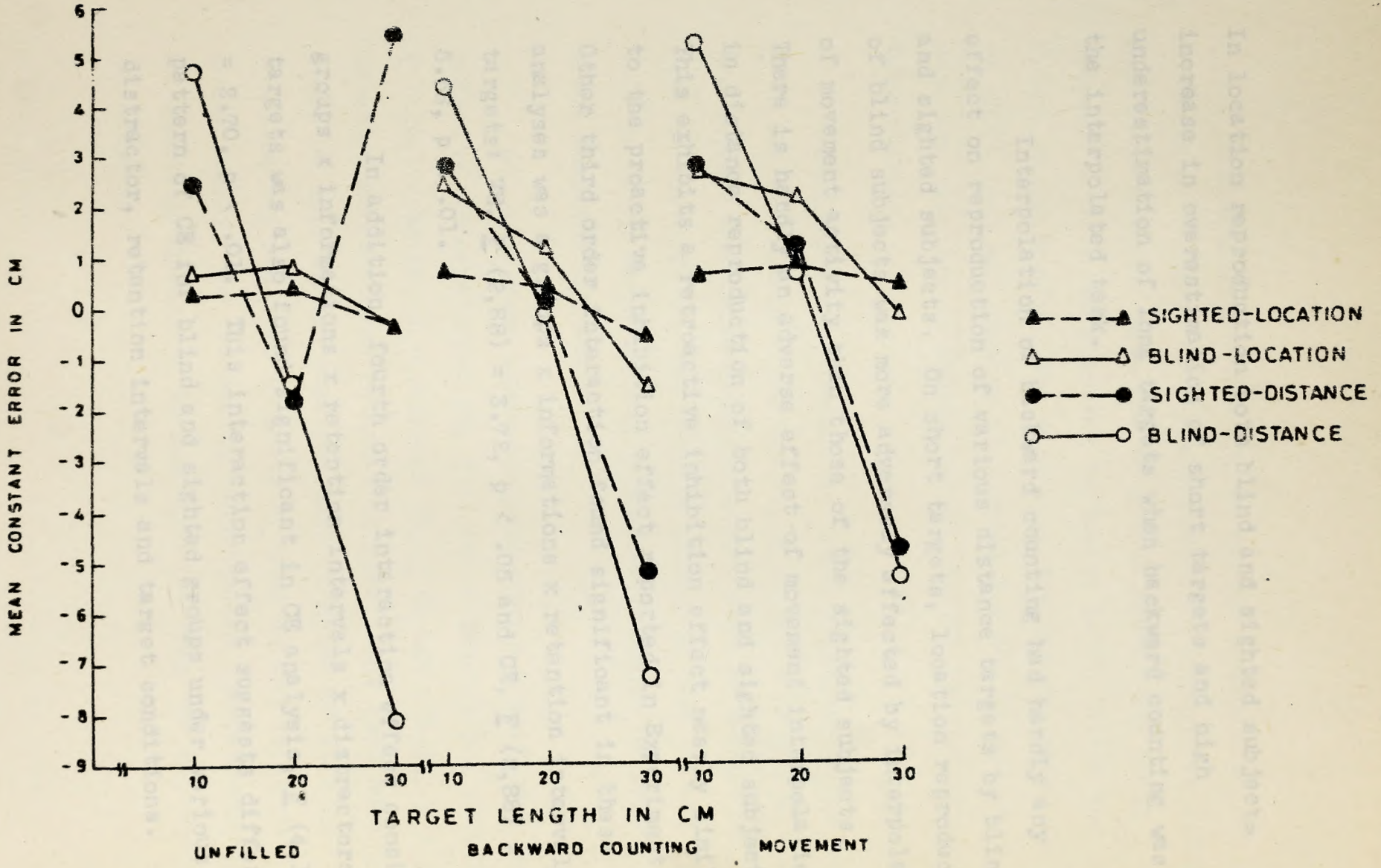


FIG. 3·6·4. MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS IN HORIZONTAL TASK AS A FUNCTION OF INFORMATIONS, DISTRACTORS AND TARGETS.

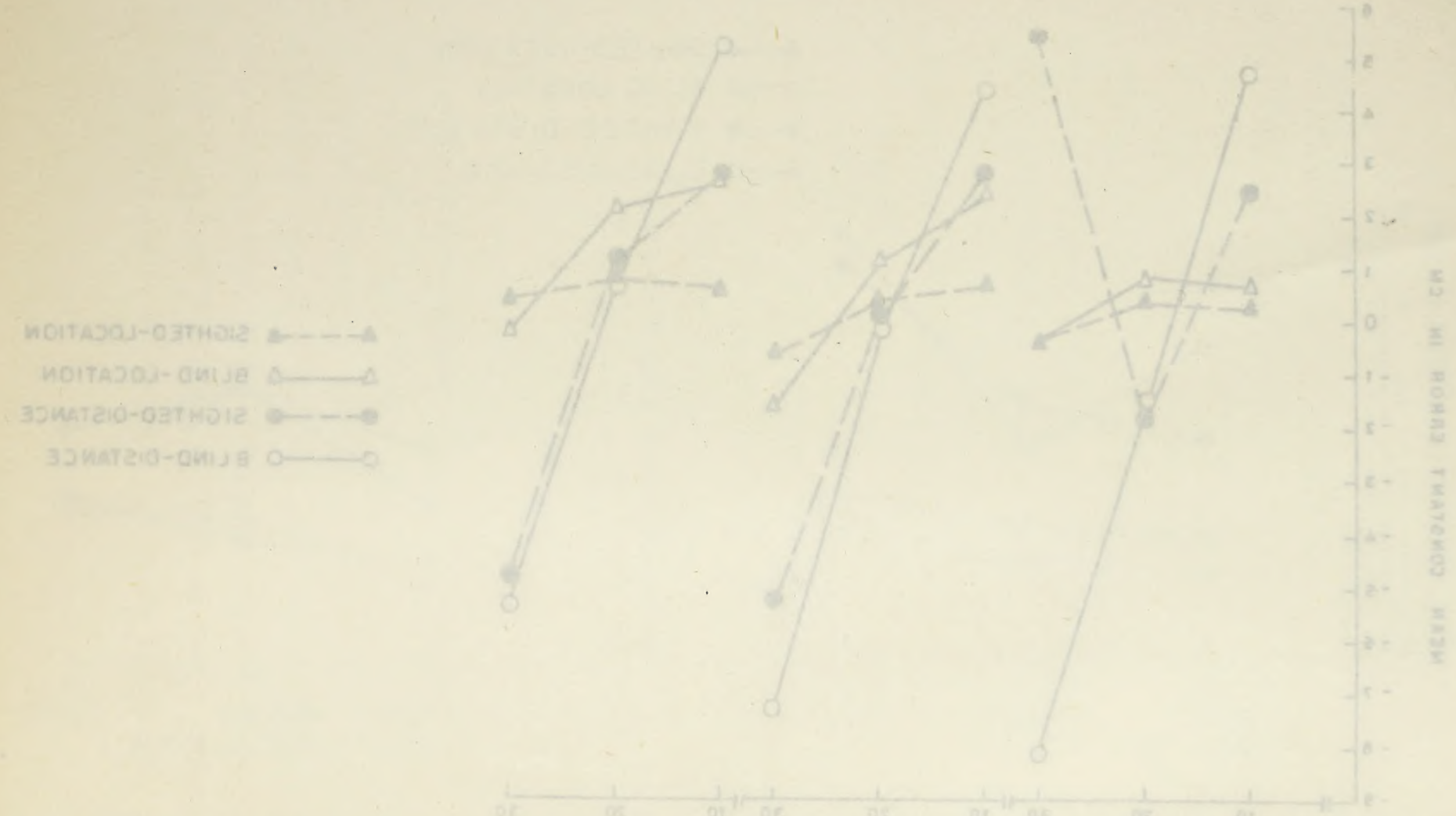


FIG. 3.6.4 MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS IN HORIZONTAL TASK AS A FUNCTION OF INFORMATIONS, DISTRACTORS AND TARGETS.

3.197 In location reproduction both blind and sighted subjects increase in overestimation of short targets and high underestimation of long targets when backward counting was the interpolated task.

Interpolation of backward counting had hardly any effect on reproduction of various distance targets by blind and sighted subjects. On short targets, location reproduction of blind subjects was more adversely affected by interpolation of movement activity than those of the sighted subjects. There is hardly an adverse effect of movement interpolation in distance reproduction of both blind and sighted subjects. This exhibits a retroactive inhibition effect nearly similar to the proactive inhibition effect reported in Experiment 3.5. Other third order interaction found significant in these analyses was a groups x informations x retention intervals x targets: VE, $\underline{F}$ (2,88) = 3.72, $p < .05$ and CE, $\underline{F}$ (2,88) = 5.58, $p < .01$.

In addition, fourth order interaction effect consisting groups x informations x retention intervals x distractors x targets was also found significant in CE analysis, $\underline{F}$ (4,176) = 2.70, $p < .01$. This interaction effect suggests different pattern of CE for blind and sighted groups under various distractor, retention intervals and target conditions.

3.198 Vertical Task. Raw AE, VE and CE scores obtained by subjects on vertical task are reported in Appendices 3.XXIV, 3.XXV and 3.XXVI. Mean AE, VE and CE scores and their respective S.D. are reported in Tables 3.6.7, 3.6.8 and 3.6.9, respectively. The data were further subjected to an ANOVA test and summary of results, for AE, VE and CE data are reported in Tables 3.6.10, 3.6.11 and 3.6.12, respectively.

Main effect of groups was found significant for AE, F (1,44) = 35.57, $p < .01$ and VE, F (1,44) = 14.01, $p < .01$. The sighted and blind groups obtained mean AE scores of 3.44 cm and 4.58 cm, and mean VE scores of 1.91 cm and 2.49 cm which shows overall poorer performance of blind group than the sighted.

All the three error analyses show a significant main effect of informations: AE, F (1,44) = 385.71, $p < .01$; VE, F (1,44) = 94.19, $p < .01$; and CE, F (1,44) = 9.21, $p < .01$. Location and distance information conditions show mean AE score of 2.12 cm and 5.89 cm; mean VE score of 1.45 cm and 2.94 cm; and mean CE score of 0.56 cm and -1.44 cm respectively. As frequently demonstrated the reproduction of location appears to be more precise than the reproduction of distance.

3.199

TABLE 3.6.7

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.55 (0.38)	2.77 (0.43)	0.40 (0.11)	3.79 (2.11)
		20	0.96 (0.31)	3.94 (0.56)	0.57 (0.18)	4.99 (1.85)
		30	1.43 (0.41)	5.14 (1.29)	1.82 (0.68)	7.78 (1.64)
	90	10	0.72 (0.34)	4.43 (0.80)	0.44 (0.13)	7.36 (3.18)
		20	1.07 (0.61)	5.26 (0.71)	0.64 (0.21)	8.08 (1.88)
		30	1.67 (0.60)	8.17 (0.62)	1.71 (0.47)	11.73 (2.62)
Counting	20	10	1.72 (0.64)	2.75 (0.64)	1.79 (0.88)	4.08 (1.90)
		20	2.12 (0.41)	3.75 (0.55)	2.14 (0.38)	4.73 (1.69)
		30	2.79 (0.55)	2.98 (0.82)	2.43 (0.65)	7.34 (2.08)
	90	10	2.43 (0.62)	3.74 (1.22)	3.16 (0.72)	6.62 (3.53)
		20	2.76 (0.69)	4.95 (0.75)	3.10 (1.10)	7.76 (2.49)
		30	3.74 (0.57)	7.84 (1.27)	3.45 (0.77)	10.82 (2.63)
Movement	20	10	1.39 (0.34)	2.64 (0.51)	1.94 (0.53)	3.93 (2.91)
		20	1.63 (0.42)	3.83 (0.98)	2.44 (0.94)	5.69 (2.99)
		30	3.18 (0.73)	5.54 (0.83)	3.42 (0.79)	7.12 (1.99)
	90	10	2.11 (0.50)	4.26 (1.21)	2.60 (0.81)	6.33 (3.35)
		20	2.78 (0.45)	4.53 (0.80)	3.62 (0.76)	6.62 (2.80)
		30	3.51 (0.46)	7.62 (1.03)	4.23 (0.97)	10.30 (3.46)

D	RI (sec)	T (cm)	SIGHTED LOCATION	SIGHTED DISTANCE	BLIND LOCATION	BLIND DISTANCE
Control	20	10	0.58 (0.38)	2.77 (0.43)	0.40 (0.11)	3.72 (2.11)
		20	0.98 (0.31)	3.04 (0.36)	0.87 (0.12)	4.88 (2.88)
		30	1.43 (0.11)	5.14 (1.29)	1.88 (0.88)	7.78 (1.48)
	90	10	0.72 (0.34)	4.43 (0.30)	0.44 (0.13)	7.96 (3.10)
		20	1.07 (0.61)	5.88 (0.71)	0.84 (0.21)	11.83 (1.89)
		30	1.57 (0.60)	8.17 (0.69)	1.71 (0.49)	12.73 (0.83)
Counting	20	10	1.72 (0.64)	2.75 (0.88)	1.75 (0.30)	4.08 (2.00)
		20	2.12 (0.41)	3.78 (0.38)	2.14 (0.39)	6.73 (2.65)
		30	2.76 (0.65)	5.98 (0.89)	2.43 (0.43)	9.34 (2.68)
	90	10	2.43 (0.69)	3.74 (1.25)	2.16 (0.73)	5.68 (3.68)
		20	2.78 (0.69)	4.98 (0.79)	3.10 (1.10)	7.78 (2.40)
		30	3.74 (0.67)	7.84 (1.29)	3.48 (0.77)	10.84 (3.87)
Movement	20	10	1.39 (0.36)	2.64 (0.81)	1.42 (0.37)	3.98 (1.61)
		20	1.65 (0.42)	3.85 (0.71)	2.41 (0.39)	5.68 (1.89)
		30	2.18 (0.73)	5.04 (0.83)	2.48 (0.78)	8.18 (1.99)
	90	10	2.11 (0.80)	3.86 (1.27)	2.30 (0.30)	6.24 (2.38)
		20	2.78 (0.48)	4.82 (0.80)	3.22 (0.78)	8.68 (2.87)
		30	3.21 (0.96)	7.68 (1.95)	4.04 (1.20)	10.20 (3.48)

3.200

TABLE 3.6.8

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.49 (0.32)	1.16 (0.75)	0.32 (0.09)	1.29 (0.69)
		20	0.95 (0.46)	2.80 (1.43)	0.48 (0.19)	3.21 (1.36)
		30	1.28 (0.37)	2.01 (1.40)	1.86 (0.72)	3.92 (2.27)
	90	10	0.64 (0.46)	1.93 (1.38)	0.30 (0.13)	2.10 (0.98)
		20	0.99 (0.45)	4.27 (1.64)	0.55 (0.21)	4.64 (3.02)
		30	1.27 (0.60)	2.04 (1.76)	1.56 (0.41)	4.17 (1.49)
Counting	20	10	0.89 (0.53)	1.70 (0.84)	0.94 (0.91)	2.51 (1.09)
		20	1.77 (0.82)	3.09 (1.20)	1.04 (0.65)	3.20 (1.45)
		30	1.62 (1.07)	1.86 (1.99)	2.25 (0.93)	2.83 (1.95)
	90	10	1.28 (0.89)	2.09 (1.48)	1.26 (0.66)	2.57 (1.53)
		20	1.87 (1.00)	3.86 (1.59)	2.17 (0.85)	5.33 (3.01)
		30	2.28 (1.41)	2.82 (2.96)	2.40 (1.45)	5.62 (4.13)
Movement	20	10	0.98 (0.59)	1.04 (0.85)	0.93 (0.42)	1.53 (0.81)
		20	1.33 (0.56)	3.64 (0.99)	1.18 (0.66)	4.10 (2.91)
		30	2.11 (1.24)	2.08 (1.95)	2.76 (1.43)	2.22 (1.37)
	90	10	1.09 (0.53)	1.38 (1.28)	1.06 (0.84)	2.81 (1.89)
		20	2.19 (0.87)	3.03 (1.64)	1.80 (1.18)	5.55 (3.15)
		30	2.58 (1.28)	2.39 (1.64)	3.83 (0.98)	5.20 (3.14)

TABLE 5.6.8

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.49 (0.32)	1.16 (0.75)	0.32 (0.09)	1.89 (0.69)
		20	0.98 (0.46)	2.80 (1.43)	0.48 (0.19)	3.21 (1.37)
		30	1.28 (0.37)	2.01 (1.40)	1.36 (0.72)	3.92 (2.27)
	90	10	0.64 (0.46)	1.93 (1.39)	0.30 (0.13)	2.10 (0.98)
		20	0.99 (0.45)	4.27 (1.84)	0.89 (0.21)	4.82 (3.02)
		30	1.27 (0.80)	3.04 (1.78)	1.36 (0.41)	4.17 (1.49)
Counting	20	10	0.89 (0.53)	1.70 (0.84)	0.94 (0.91)	2.81 (1.09)
		20	1.77 (0.82)	3.09 (1.80)	1.04 (0.05)	3.20 (1.46)
		30	1.82 (1.07)	1.86 (1.09)	2.25 (0.93)	2.82 (1.95)
	90	10	1.28 (0.89)	2.09 (1.49)	1.28 (0.86)	2.87 (1.88)
		20	1.87 (1.00)	3.86 (1.89)	2.17 (0.89)	3.53 (2.01)
		30	2.26 (1.41)	2.82 (2.96)	2.60 (1.47)	3.89 (4.15)
Movement	20	10	0.98 (0.59)	1.04 (0.85)	0.97 (0.42)	1.83 (0.81)
		20	1.33 (0.96)	3.84 (0.92)	1.18 (0.66)	4.10 (2.91)
		30	2.11 (1.24)	2.08 (1.95)	2.78 (1.43)	2.29 (1.37)
	90	10	1.09 (0.53)	1.38 (1.28)	1.08 (0.84)	2.81 (1.89)
		20	2.18 (0.87)	3.03 (1.64)	1.80 (1.18)	3.56 (3.15)
		30	2.58 (1.28)	2.39 (1.64)	2.83 (0.88)	3.20 (3.14)

3.201

TABLE 3.6.9

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.27 (0.48)	1.70 (1.49)	0.67 (0.35)	3.86 (1.87)
		20	0.16 (0.51)	-1.83 (2.59)	0.56 (0.62)	-2.03 (1.74)
		30	-0.10 (1.02)	-3.95 (2.47)	-0.55 (1.57)	-7.18 (2.14)
	90	10	0.31 (0.60)	3.30 (2.33)	0.69 (0.29)	5.72 (2.87)
		20	0.46 (0.59)	-1.80 (3.42)	0.90 (0.56)	-1.00 (2.61)
		30	-0.64 (1.25)	-7.04 (3.95)	-0.20 (1.26)	-9.03 (2.52)
Counting	20	10	1.06 (0.85)	2.23 (1.34)	1.43 (0.34)	-4.43 (1.83)
		20	0.27 (1.22)	0.39 (3.11)	1.04 (1.10)	-0.43 (2.48)
		30	-0.99 (1.44)	-4.07 (4.26)	0.34 (2.20)	-6.63 (2.13)
	90	10	0.26 (1.98)	3.39 (2.07)	3.57 (1.33)	4.35 (2.76)
		20	0.65 (1.74)	-0.03 (2.21)	1.17 (2.56)	0.21 (2.22)
		30	-0.28 (2.55)	-6.33 (4.14)	-2.20 (3.06)	-7.97 (2.09)
Movement	20	10	0.86 (0.88)	1.88 (1.44)	2.06 (1.00)	4.43 (2.35)
		20	0.79 (0.91)	0.98 (2.73)	1.28 (1.21)	0.77 (2.00)
		30	0.17 (1.37)	-4.09 (4.07)	-0.08 (2.08)	-5.47 (2.18)
	90	10	0.51 (1.36)	3.82 (1.79)	3.01 (1.39)	5.93 (2.03)
		20	0.64 (1.45)	1.44 (3.20)	2.92 (1.51)	0.55 (2.76)
		30	0.64 (1.71)	-5.48 (4.19)	-0.44 (3.01)	-6.39 (3.56)

TABLE 3.6.9

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN CM) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF VERTICAL LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (cm)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	10	0.27 (0.48)	1.70 (1.49)	0.67 (0.35)	8.86 (1.87)
		20	0.16 (0.81)	-1.83 (2.89)	0.86 (0.82)	-2.03 (1.74)
		30	-0.10 (1.02)	-3.95 (2.47)	-0.85 (1.87)	-7.18 (2.14)
	90	10	0.31 (0.60)	3.30 (2.33)	0.89 (0.29)	5.72 (2.87)
		20	0.46 (0.89)	-1.80 (3.42)	0.90 (0.86)	-1.00 (2.81)
		30	-0.64 (1.25)	-7.04 (3.95)	-0.20 (1.96)	-5.03 (2.82)
Counting	20	10	1.06 (0.85)	2.23 (1.34)	1.43 (0.34)	-4.43 (1.87)
		20	0.27 (1.22)	0.39 (3.11)	1.04 (1.10)	-0.43 (2.48)
		30	-0.39 (1.44)	-4.07 (4.36)	0.34 (2.20)	-6.65 (2.13)
	90	10	0.26 (1.98)	3.39 (2.07)	1.37 (1.33)	4.33 (2.76)
		20	0.85 (1.74)	-0.05 (2.21)	1.17 (2.36)	0.21 (2.22)
		30	-0.28 (2.55)	-6.33 (4.14)	-2.30 (3.08)	-7.27 (2.09)
Movement	20	10	0.96 (0.88)	1.89 (1.44)	2.06 (1.00)	4.43 (2.35)
		20	0.79 (0.91)	0.66 (2.73)	1.28 (1.21)	0.77 (2.00)
		30	0.17 (1.37)	-4.09 (4.07)	-0.08 (2.08)	-8.47 (2.18)
	90	10	0.51 (1.36)	3.82 (1.79)	2.01 (1.39)	8.27 (2.03)
		20	0.84 (1.45)	1.44 (2.20)	2.32 (1.31)	0.86 (2.76)
		30	0.84 (1.71)	-5.48 (4.19)	-0.44 (3.01)	-6.36 (3.86)

3.202

TABLE 3.6.10

SUMMARY OF ANOVA OBTAINED FOR AE SCORES OF VERTICAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	3906.92	47			
Groups (G)	283.40	1	283.40	35.57	.01
Informations (I)	3073.26	1	3073.26	385.71	.01
G x I	199.68	1	199.68	25.06	.01
Subjects within groups	350.58	44	7.97		
Within subjects	3391.11	816			
Retention Intervals (R)	445.23	1	445.23	407.83	.01
G x R	26.77	1	28.77	24.52	.01
I x R	146.07	1	146.07	133.80	.01
G x I x R	19.33	1	19.33	17.70	.01
R x subjects within groups	48.04	44	1.09		
Distractors (D)	87.76	2	43.88	32.64	.01
G x D	1.65	2	0.82	0.61	-
I x D	199.63	2	99.81	74.25	.01
G x I x D	12.04	2	6.02	4.48	.05
D x subjects within groups	118.29	88	1.34		
Targets (T)	857.41	2	428.71	58.46	.01
G x T	2.37	2	1.18	0.16	-
I x T	221.97	2	110.99	15.13	.01
G x I x T	4.83	2	2.42	0.33	-
T x subjects within groups	645.36	88	7.33		

TABLE 3.6.10

SUMMARY OF ANOVA OBTAINED FOR AS SCORES OF VERTICAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p.
Between subjects	3906.92	47			
Groups (G)	283.40	1	283.40	35.67	.01
Informations (I)	3073.36	1	3073.36	385.71	.01
G x I	199.68	1	199.68	25.06	.01
Subjects within groups	380.38	44	7.97		
Within subjects	3391.11	816			
Retention Intervals (R)	445.23	1	445.23	407.80	.01
G x R	26.77	1	26.77	24.08	.01
I x R	146.07	1	146.07	133.80	.01
G x I x R	19.33	1	18.33	17.90	.01
R x subjects within groups	48.04	44	1.09		
Distractors (D)	87.76	2	43.88	32.64	.01
G x D	1.65	2	0.82	0.61	-
I x D	199.63	2	99.81	74.25	.01
G x I x D	12.04	2	6.02	4.48	.05
D x subjects within groups	118.29	88	1.34		
Targets (T)	857.41	2	428.71	58.46	.01
G x T	2.37	2	1.18	0.16	-
I x T	221.97	2	110.99	15.13	.01
G x I x T	4.83	2	2.42	0.33	-
T x subjects within groups	646.36	88	7.34		

3.203

TABLE 3.6.10 (CONTD.)

Source	SS	df	MS	F	p
R x D	2.20	2	1.10	1.34	-
G x R x D	3.10	2	1.55	2.18	-
I x R x D	29.90	2	14.95	21.01	.01
G x I x R x D	3.01	2	1.50	2.11	-
RD x subjects within groups	62.63	88	0.71		
R x T	10.88	2	5.44	4.39	.05
G x R x T	0.25	2	0.13	0.10	-
I x R x T	17.14	2	8.57	6.91	.01
G x I x R x T	0.00	2	0.00	0.00	-
RT x subjects within groups	108.96	88	1.24		
D x T	1.12	4	0.28	0.32	-
G x D x T	11.57	4	2.89	3.29	.05
I x D x T	7.65	4	1.91	2.17	-
G x I x D x T	0.17	4	0.04	0.05	-
DT x subjects within groups	154.85	176	0.88		
R x D x T	1.26	4	0.31	0.44	-
G x R x D x T	2.68	4	0.57	0.93	-
I x R x D x T	9.39	4	2.35	3.27	.05
G x I x R x D x T	1.89	4	0.47	0.66	
RDT x subjects within groups	126.38	176	0.72		
Total	7298.03	863			

TABLE 5.6.10 (CONTD.)

Source	SS	df	MS	F	p
R x D					
G x R x D					
I x R x D					
G x I x R x D					
RD x subjects within groups					
R x T					
G x R x T					
I x R x T					
G x I x R x T					
RT x subjects within groups					
D x T					
G x D x T					
I x D x T					
G x I x D x T					
DT x subjects within groups					
R x D x T					
G x R x D x T					
I x R x D x T					
G x I x R x D x T					
RDT x subjects within groups					
Total					

3.204

TABLE 3.6.11

SUMMARY OF ANOVA OBTAINED FOR VE SCORES OF VERTICAL TASKS IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	834.20	47			
Groups (G)	71.51	1	71.51	14.01	.01
Informations (I)	480.91	1	480.91	94.19	.01
G x I	57.13	1	57.13	11.19	.01
Subjects within groups	224.65	44	5.11		
Within subjects	2362.22	816			
Retention Intervals (R)	92.59	1	92.59	82.88	.01
G x R	14.00	1	14.00	12.53	.01
I x R	22.76	1	22.76	20.37	.01
G x I x R	11.63	1	11.68	10.45	.01
R x subjects within groups	49.16	44	1.12		
Distractors (D)	54.80	2	27.40	16.10	.01
G x D	5.19	2	2.60	1.53	-
I x D	23.54	2	11.77	6.92	.01
G x I x D	0.23	2	0.11	0.07	-
D x subjects within groups	149.71	88	1.70		
Targets (T)	313.78	2	156.89	37.74	.01
G x T	41.13	2	20.56	4.95	.01
I x T	117.02	2	58.51	14.08	.01
G x I x T	3.38	2	1.69	0.41	-
T x subjects within groups	365.80	88	4.16		

3.205

TABLE 3.6.11 (CONTD.)

Source	SS	df	MS	F	p
R x D	7.70	2	3.85	2.37	-
G x R x D	9.93	2	4.96	3.05	.05
I x R x D	1.55	2	0.78	0.48	-
G x I x R x D	5.44	2	2.72	1.67	-
RD x subjects within groups	143.02	88	1.63		
R x T	7.47	2	3.73	1.78	-
G x R x T	5.17	2	2.59	1.24	-
I x R x T	1.88	2	0.94	0.45	-
G x I x R x T	4.09	2	2.04	0.98	-
RT x subjects within groups	183.91	88	2.09		
D x T	6.54	4	1.63	1.10	-
G x D x T	3.32	4	0.83	0.56	-
I x D x T	13.18	4	3.29	2.22	-
G x I x D x T	7.88	4	1.97	1.33	-
DT x subjects within groups	261.05	176	1.48		
R x D x T	17.70	4	4.42	1.97	-
G x R x D x T	4.93	4	1.23	0.55	-
I x R x D x T	14.69	4	3.67	1.64	-
G x I x R x D x T	3.37	4	0.84	0.38	-
RDT x subjects within groups	394.67	176	2.24		
Total	3196.42	863			

3.206

TABLE 3.6.12

SUMMARY OF ANOVA OBTAINED FOR CE SCORES OF VERTICAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	3720.65	47			
Groups (G)	56.53	1	56.58	0.83	-
Informations (I)	626.28	1	626.28	9.21	.01
G x I	45.28	1	45.28	0.67	-
Subjects within groups	2992.51	44	68.01		
Within subjects	12219.14	816			
Retention Intervals (R)	2.44	1	2.44	0.57	-
G x R	2.51	1	2.51	0.59	-
I x R	11.83	1	11.83	2.78	-
G x I x R	0.07	1	0.07	0.02	-
R x subjects within groups	187.11	44	4.25		
Distractors (D)	49.60	2	24.80	6.93	.01
G x D	23.88	2	11.94	3.34	.05
I x D	16.09	2	8.05	2.25	-
G x I x D	12.61	2	6.31	1.76	-
D x subjects within groups	314.75	88	3.58		
Targets (T)	5517.54	2	2758.77	329.88	.01
G x T	148.62	2	74.31	8.88	.01
I x T	2646.97	2	1323.49	158.26	.01
G x I x T	183.26	2	91.63	10.96	.01
T x subjects within groups	735.93	88	8.36		

TABLE 3.6.12

SUMMARY OF ANOVA OBTAINED FOR OK SCORES OF VERTICAL TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	3720.65	47			
Groups (G)	50.82	1	50.82	0.63	-
Informations (I)	696.98	1	696.98	8.71	.01
G x I	48.98	1	48.98	0.61	-
Subjects within groups	2965.81	44	68.01		
Within subjects	12219.14	816			
Rotation Intervals (R)	5.44	1	5.44	0.07	-
G x R	5.81	1	5.81	0.08	-
I x R	11.83	1	11.83	0.16	-
G x I x R	0.07	1	0.07	0.00	-
R x subjects within groups	1271.11	44			
Distractors (D)	49.80	1	24.90	0.33	.71
G x D	23.85	1	11.94	0.16	.84
I x D	16.06	1	8.03	0.11	-
G x I x D	19.31	1	9.66	0.13	-
D x subjects within groups	3164.76	88			
Targets (T)	6510.81	2	3255.41	42.89	.01
G x T	148.82	2	74.41	0.98	.01
I x T	2040.27	2	1020.14	13.44	.01
G x I x T	183.36	2	91.68	1.21	.01
T x subjects within groups	7584.93	88			

3.207

TABLE 3.6.12 (CONTD.)

Source	SS	df	MS	F	p
R x D	15.31	2	7.65	2.77	-
G x R x D	6.13	2	3.06	1.11	-
I x R x D	4.22	2	2.11	0.76	-
G x I x R x D	2.86	2	1.43	0.52	-
RD x subjects within groups	243.18	88	2.76		
R x T	300.01	2	150.01	55.77	.01
G x R x T	9.54	2	4.77	1.77	-
I x R x T	138.89	2	69.45	25.82	.01
G x I x R x T	9.45	2	4.72	1.75	-
RT x subjects within groups	236.33	88	2.69		
D x T	21.55	4	5.39	1.65	-
G x D x T	18.01	4	4.50	1.38	-
I x D x T	102.90	4	25.72	7.38	.01
G x I x D x T	46.43	4	11.61	3.56	.01
DT x subjects within groups	574.24	176	3.26		
R x D x T	22.99	4	5.75	1.88	-
G x R x D x T	10.62	4	2.66	0.87	-
I x R x D x T	60.42	4	15.11	4.93	.01
G x I x R x D x T	3.84	4	0.96	0.31	-
RDT x subjects within groups	539.02	176	3.06		
Total	15939.79	863			

3.208 A significant main effect of retention intervals was revealed in AE, F (1,44) = 407.83, $p < .01$, and VE, F (1,44) = 82.88, $p < .01$. Mean scores for 20 sec and 90 sec retention intervals obtained in AE analysis are 3.29 cm and 4.73 cm, and VE analysis are 1.87 cm and 2.53 cm. These mean scores indicate that variability in reproduction increases with delay in reproduction.

All the three error analyses showed significant main effect of distractors: AE, F (2,88) = 32.64, $p < .01$; VE, F (2,88) = 16.10, $p < .01$; and CE, F (2,88) = 6.93, $p < .01$. For unfilled counting and movement interpolation conditions mean AE scores are 3.56 cm, 4.25 cm and 4.22 cm; mean VE scores are 1.84 cm, 2.39 cm and 2.38 cm; and mean CE scores are -0.55 cm, -0.36 cm and 0.03 cm, respectively. These results support the observations of the horizontal movement reproduction of this experiment.

Main effect of targets is also significant in all the three error analyses: AE, F (2,88) = 58.46, $p < .01$; VE, F (2,88) = 37.74, $p < .01$; and CE, F (2,88) = 329.88, $p < .01$. Target conditions of 10 cm, 20 cm and 30 cm reveal mean AE score of 3.00 cm, 3.67 cm and 5.36 cm, mean VE scores of 1.35 cm, 2.63 cm and 2.62 cm, and mean CE scores of 2.50 cm, 0.24 cm and -3.62 cm. The pattern of this data appears to be different from that of the results obtained for horizontal task of this experiment. The middle 20 cm target does not

3.209 show the depression in error obtained for the horizontal task. It appears that the coding of 20 cm middle target in the horizontal plane does not give the same information about limb position when the same operation is made on the vertical plane.

An interesting groups x informations interaction effect was highly significant for AE, $\underline{F}$ (1,44) = 25.06, $p < .01$, and VE, $\underline{F}$ (1,44) = 11.19, $p < .01$. Both AE and VE data revealed that groups differed only in reproduction of distance information, the blind group being poorer than their sighted counterparts. This confirms the overall observations reported in Experiments 3.4 and 3.5. This finding seems to favour the role of visual reference in coding of distance information.

A groups x retention intervals interaction was significant for AE, $\underline{F}$ (1,44) = 24.52, $p < .01$, and VE, $\underline{F}$ (1,44) = 12.53, $p < .01$. It is revealed on the basis of both AE and VE data that the blind group showed quicker forgetting than their sighted counterpart when the length of retention interval increased.

First order interaction effect of groups x targets is significant for VE, $\underline{F}$ (2,88) = 4.95, $p < .01$, and CE, $\underline{F}$ (2,88) = 8.88, $p < .01$. This interaction effect revealed that the blind subjects show higher VE which increased consistently with increase in length of targets, while the sighted subjects did not show this trend consistently.

3.210 Among second order interaction effect an interesting groups x informations x retention intervals interaction effect was significant for AE, F (1,44) = 17.70, $p < .01$, and for VE, F (1,44) = 10.45, $p < .01$. It revealed a similar trend of loss of information for both blind and sighted in location reproduction. In distance reproduction this tendency is comparatively stronger for the blind groups than for the sighted. This trend was consistent for both AE and VE data.

Most interesting among the second order interaction effect is groups x informations x distractors interaction effect which is significant in AE analysis, F (2,88) = 4.48, $p < .05$. This trend of data is similar to that of the data of horizontal task.

Another crucial second order interaction effect is groups x distractor x targets which is significant in AE analysis, F (4,197) = 3.29, $p < .05$. This implies that the two groups are differently affected by distractors on short and long targets.

Most interesting among the third order interaction is a groups x informations x distractors x targets interaction effect which is significant in CE analysis, F (4,176) = 3.56, $p < .01$. As also found significant in AE analysis of the horizontal task, this interaction effect suggests distinct effect of distractors and targets in location and distance

.211 reproduction of the two groups. The pattern of data are similar to the one observed for the reproduction of horizontal task.

Curvilinear Task. Raw AE, VE and CE scores of subjects on curvilinear task are reported in Appendices 3.XXVII, 3.XXVIII and 3.XXIX. Mean AE, VE and CE and the SD scores of different groups under all treatment conditions separately ~~is~~ are reported in Tables 3.6.13, 3.6.14 and 3.6.15. AE, VE and CE data were further subjected to an ANOVA test and its summary is reported in Tables 3.6.16, 3.6.17 and 3.6.18.

Main effect of groups in curvilinear task is significant only in CE analysis, F (1,44) = 9.95, $p < .01$. Mean CE scores of sighted and blind groups are -0.47° and -3.56°, respectively. It reflects a stronger tendency of overestimation in sighted group than the blind group in reproduction of curvilinear movements.

Information emerges as an important variable in all the three error analysis: AE, F (1,44) = 129.22, $p < .01$; VE, F (1,44) = 111.33, $p < .01$; and CE, F (1,44) = 7.28, $p < .01$. Two informations, viz. location and distance, have mean AE scores of 4.13° and 8.47°; mean VE scores of 4.13° and 8.47°; and mean CE scores of -0.69° and -3.38°, respectively. Like horizontal and vertical tasks, reproduction of location is more precise than the distance even for curvilinear movement.

3.212

TABLE 3.6.13

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGETS (T) CONDITIONS

D	RI (sec)	T (deg.)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	30	1.69 (0.76)	12.13 (4.85)	2.10 (0.74)	14.13 (8.53)
		70	3.17 (1.37)	11.04 (3.56)	3.04 (0.91)	11.08 (4.47)
		110	5.42 (1.17)	17.19 (7.48)	4.88 (2.19)	26.54 (6.40)
	90	30	1.58 (0.59)	19.43 (6.75)	2.08 (0.83)	16.38 (9.93)
		70	2.75 (1.08)	17.21 (7.18)	2.85 (0.65)	12.38 (5.42)
		110	4.79 (1.42)	26.50 (12.35)	4.48 (1.35)	31.98 (9.79)
Counting	20	30	7.13 (5.99)	11.08 (4.65)	7.04 (4.81)	13.90 (6.39)
		70	7.52 (1.19)	12.99 (2.95)	6.17 (2.36)	12.38 (9.65)
		110	8.56 (2.03)	18.08 (8.60)	8.60 (4.08)	29.33 (4.03)
	90	30	8.29 (2.94)	16.23 (8.45)	10.69 (5.62)	19.40 (9.43)
		70	9.40 (2.81)	15.19 (6.42)	7.06 (2.38)	13.65 (3.36)
		110	12.60 (2.95)	23.06 (11.56)	12.02 (5.84)	34.85 (6.94)
Movement	20	30	3.98 (1.35)	12.27 (6.35)	6.08 (3.70)	13.81 (8.34)
		70	6.08 (1.53)	11.38 (2.18)	6.15 (2.31)	10.33 (4.10)
		110	7.85 (1.55)	16.88 (6.67)	9.79 (5.04)	27.17 (8.81)
	90	30	6.50 (1.50)	15.38 (8.82)	8.63 (5.00)	17.77 (9.58)
		70	7.40 (2.30)	16.44 (16.31)	7.38 (2.39)	13.29 (5.00)
		110	9.29 (2.74)	21.98 (9.39)	10.73 (5.31)	29.54 (8.29)

3.213

TABLE 3.6.14

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (deg.)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	30	1.42 (0.78)	4.59 (2.38)	1.87 (0.78)	7.68 (7.57)
		70	3.17 (1.51)	9.52 (9.03)	2.30 (0.86)	8.28 (4.12)
		110	3.84 (2.55)	6.91 (6.38)	3.49 (1.80)	6.04 (3.80)
	90	30	1.60 (0.62)	8.41 (5.71)	1.63 (0.72)	6.66 (3.94)
		70	2.64 (1.12)	12.88 (6.50)	2.60 (1.11)	8.36 (5.04)
		110	3.28 (2.28)	12.19 (10.49)	3.37 (1.85)	6.02 (2.31)
Counting	20	30	5.70 (10.16)	4.84 (2.92)	3.38 (2.08)	8.23 (6.36)
		70	5.32 (2.85)	10.75 (3.59)	3.98 (2.26)	8.85 (5.48)
		110	4.74 (2.72)	9.74 (6.39)	5.11 (2.58)	7.14 (3.70)
	90	30	3.86 (2.84)	7.40 (4.17)	4.13 (2.37)	10.65 (8.72)
		70	4.43 (3.12)	11.87 (7.22)	5.92 (2.58)	10.28 (3.96)
		110	5.29 (5.26)	12.42 (10.81)	6.19 (2.92)	6.51 (2.15)
Movement	20	30	2.50 (1.28)	7.59 (7.09)	3.66 (3.80)	4.69 (2.35)
		70	5.23 (1.87)	8.95 (3.84)	6.10 (3.15)	9.69 (3.75)
		110	3.84 (2.68)	4.77 (2.36)	5.27 (3.36)	6.31 (3.08)
	90	30	3.29 (1.68)	8.14 (6.41)	5.47 (4.05)	7.42 (6.00)
		70	5.94 (2.68)	10.28 (7.28)	6.47 (2.22)	8.95 (4.87)
		110	5.16 (3.39)	10.79 (7.78)	6.69 (2.37)	10.96 (7.78)

MEAN AND S.D. (GIVEN IN BRACKETS) OF VM SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (deg.)	SIGHTED LOCATION	SIGHTED DISTANCE	BLIND LOCATION	BLIND DISTANCE
Control	20	30	1.42 (0.78)	4.59 (2.38)	1.87 (0.78)	7.68 (7.87)
		70	3.17 (1.81)	9.52 (9.03)	2.30 (0.88)	8.28 (4.12)
		110	3.84 (2.85)	6.91 (6.38)	3.45 (1.80)	6.04 (3.80)
	90	30	1.60 (0.82)	8.41 (8.71)	1.83 (0.72)	6.86 (3.94)
		70	2.64 (1.12)	12.88 (6.80)	2.60 (1.11)	8.38 (6.01)
		110	3.28 (2.28)	12.19 (10.49)	3.37 (1.85)	6.02 (2.31)
Counting	20	30	5.70 (10.16)	4.84 (2.92)	3.38 (2.08)	8.23 (6.35)
		70	5.32 (2.80)	10.75 (3.89)	3.08 (2.29)	8.86 (5.49)
		110	4.74 (2.72)	9.74 (6.30)	5.11 (2.89)	7.14 (3.70)
	90	30	3.86 (2.84)	7.40 (6.17)	4.13 (2.87)	10.68 (6.72)
		70	4.43 (3.12)	11.87 (7.28)	5.02 (2.85)	10.08 (3.68)
		110	5.20 (5.28)	12.48 (10.81)	5.18 (2.92)	6.31 (2.13)
Movement	20	30	2.80 (1.28)	7.89 (7.09)	3.06 (2.87)	4.69 (2.35)
		70	3.23 (1.87)	8.24 (5.84)	4.12 (3.48)	5.89 (3.75)
		110	3.84 (2.68)	4.77 (3.38)	5.27 (3.58)	6.31 (4.08)
	90	30	3.29 (1.68)	8.14 (6.41)	3.47 (1.08)	7.42 (6.00)
		70	5.04 (2.65)	10.28 (7.28)	6.47 (2.28)	8.65 (4.37)
		110	5.16 (3.38)	10.79 (7.78)	6.89 (2.37)	10.04 (6.78)

3.214

TABLE 3.6.15

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR LOCATION AND DISTANCE TARGETS UNDER DISTRACTOR (D), RETENTION INTERVAL (R) AND TARGET (T) CONDITIONS

D	RI (sec)	T (deg.)	SIGHTED		BLIND	
			LOCATION	DISTANCE	LOCATION	DISTANCE
Control	20	30	0.31 (1.42)	11.00 (6.45)	1.10 (1.03)	12.00 (7.73)
		70	-1.38 (1.41)	2.67 (6.53)	-1.21 (2.29)	-6.79 (6.84)
		110	-1.75 (3.49)	-13.60 (10.12)	-3.46 (3.36)	-26.21 (6.93)
	90	30	0.79 (0.73)	14.97 (11.76)	1.25 (1.47)	14.21 (12.91)
		70	0.71 (1.83)	10.25 (8.55)	-1.23 (1.44)	-3.63 (10.47)
		110	-3.29 (1.83)	-20.79 (14.49)	-2.52 (2.39)	-31.98 (9.79)
Counting	20	30	5.75 (6.87)	9.00 (7.05)	6.96 (4.89)	9.73 (8.79)
		70	0.65 (5.34)	1.98 (7.23)	-1.00 (5.74)	-3.17 (9.68)
		110	-6.56 (3.58)	-14.92 (9.37)	-7.06 (5.70)	-29.33 (4.03)
	90	30	6.92 (3.75)	11.48 (11.59)	10.69 (5.62)	15.06 (11.47)
		70	-0.31 (8.83)	2.69 (11.74)	0.02 (5.01)	-4.69 (9.81)
		110	-8.65 (7.06)	-17.65 (11.71)	-10.35 (7.46)	-34.85 (6.94)
Movement	20	30	1.98 (3.08)	8.06 (6.63)	4.67 (3.30)	12.69 (9.95)
		70	0.17 (3.66)	1.92 (7.84)	-0.15 (4.00)	-3.00 (5.95)
		110	-4.85 (5.39)	-16.71 (6.97)	-8.63 (5.74)	-27.17 (8.81)
	90	30	5.63 (2.53)	11.71 (10.21)	7.21 (5.70)	16.48 (9.32)
		70	-0.65 (4.90)	9.06 (10.24)	-1.83 (4.97)	3.79 (11.26)
		110	-6.71 (4.11)	-16.73 (12.96)	-8.10 (7.36)	-27.71 (8.96)

3.215

TABLE 3.6.16

SUMMARY OF ANOVA OBTAINED FOR AE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	38177.75	47			
Groups (G)	595.44	1	595.44	2.77	-
Informations (I)	27746.81	1	27746.81	129.22	.01
G x I	387.56	1	387.56	1.80	-
Subjects within groups	9447.94	44	214.73		
Within subjects	36424.44	816			
Retention Intervals(R)	1760.25	1	1760.25	60.88	.01
G x R	51.13	1	51.13	1.77	-
I x R	526.88	1	526.88	18.22	.01
G x I x R	61.88	1	61.88	2.14	-
R x subjects within groups	1272.19	44	28.91		
Distractors (D)	1233.25	2	615.63	40.60	.01
G x D	89.13	2	46.56	2.93	-
I x D	1270.13	2	635.06	41.81	.01
G x I x D	132.38	2	66.19	4.36	.05
D x subjects within groups	1336.50	88	15.19		
Targets (T)	9240.00	2	4620.00	52.65	.01
G x T	1304.31	2	625.16	7.43	.01
I x T	3675.56	2	1837.78	20.94	.01
G x I x T	1081.94	2	540.97	6.17	.01
T x subjects within groups	7721.81	88	87.75		

TABLE 3.6.15

SUMMARY OF ANOVA OBTAINED FOR AE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects					
Groups (G)					
Information (I)					
G x I					
Subjects within groups					
Within subjects					
Retention Interval (R)					
G x R					
I x R					
G x I x R					
R x subjects within groups					
Distractors (D)					
G x D					
I x D					
G x I x D					
D x subjects within groups					
Targets (T)					
G x T					
I x T					
G x I x T					
T x subjects within groups					

3.216

TABLE 3.6.16 (CONTD.)

Source	SS	df	MS	F	p
R x D	28.25	2	14.13	1.24	-
G x R x D	47.31	2	23.66	2.08	-
I x R x D	165.44	2	82.72	7.29	.01
G x I x R x D	47.81	2	23.91	2.11	-
RD x subjects within groups	998.56	88	11.35		
R x T	80.94	2	40.47	5.50	.01
G x R x T	17.00	2	8.50	1.15	-
I x R x T	22.06	2	11.03	1.50	-
G x I x R x T	1.19	2	0.59	0.08	-
RT x subjects within groups	647.56	88	7.36		
D x T	29.44	4	7.36	0.64	-
G x D x T	45.38	4	11.34	0.99	-
I x D x T	90.50	4	22.63	1.98	-
G x I x D x T	9.63	4	2.41	0.21	-
DT x subjects within groups	2013.69	176	11.44		
R x D x T	62.25	4	15.56	2.16	-
G x R x D x T	18.94	4	4.73	0.66	-
I x R x D x T	54.19	4	13.55	1.88	-
G x I x R x D x T	25.56	4	6.39	0.89	-
RDT x subjects within groups	1269.63	176	7.21		
Total	74602.19	863			

TABLE 3.6.16 (CONTD.)

Source	SS	df	MS	F	P
R x D	288.58	2	144.13	1.88	-
G x R x D	47.31	2	23.66	0.06	-
I x R x D	165.44	2	82.72	0.28	.01
G x I x R x D	47.81	2	23.91	0.11	-
RD x subjects within groups	998.68	88	11.36		
R x T	80.94	2	40.47	0.80	.01
G x R x T	17.00	2	8.50	1.18	-
I x R x T	22.06	2	11.03	1.50	-
G x I x R x T	1.19	2	0.59	0.08	-
RT x subjects within groups	647.56	88	7.36		
D x T	29.44	4	7.36	0.04	-
G x D x T	45.36	4	11.34	0.06	-
I x D x T	90.80	4	22.65	1.28	-
G x I x D x T	9.67	4	2.41	0.01	-
DT x subjects within groups	3017.68	176	17.14		
R x D x T	69.28	4	17.32	2.36	-
G x R x D x T	18.04	4	4.51	0.86	-
I x R x D x T	84.10	4	21.03	1.88	-
G x I x R x D x T	28.80	4	7.20	0.80	-
RDT x subjects within groups	1265.63	176	7.21		
Total	7160.19	863			

3.217

TABLE 3.6.17

SUMMARY OF ANOVA OBTAINED FOR VE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	5789.63	47			
Groups (G)	28.11	1	28.11	0.77	-
Informations (I)	4050.69	1	4050.69	111.33	.01
G x I	109.85	1	109.85	3.02	-
Subjects within groups	1600.98	44	36.39		
Within subjects	17976.21	816			
Retention Intervals(R)	303.16	1	303.16	16.72	.01
G x R	17.20	1	17.20	0.95	-
I x R	135.73	1	135.73	7.49	.01
G x I x R	107.60	1	107.60	5.93	.05
R x subjects within groups	797.86	44	18.13		
Distractors (D)	396.23	2	198.11	11.22	.01
G x D	77.11	2	38.55	2.18	-
I x D	188.49	2	94.24	5.34	.01
G x I x D	11.23	2	5.62	0.32	-
D x subjects within groups	1554.48	88	17.56		
Targets (T)	592.34	2	296.17	7.98	.01
G x T	81.41	2	40.71	1.10	-
I x T	123.56	2	61.78	1.66	-
G x I x T	107.27	2	53.53	1.44	-
T x subjects within groups	3266.84	88	37.12		

TABLE 3.6.17

SUMMARY OF ANOVA OBTAINED FOR VE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	8788.65	47			
Groups (G)	28.11	1	28.11	0.77	-
Informations (I)	4080.69	1	4080.69	111.33	.01
G x I	109.85	1	109.85	3.02	-
Subjects within groups	1600.98	44	36.39		
Within subjects	1796.21	816			
Retention Intervals(R)	303.16	1	303.16	16.72	.01
G x R	17.20	1	17.20	0.95	-
I x R	135.73	1	135.73	7.49	.01
G x I x R	107.60	1	107.60	5.93	.05
R x subjects within groups	797.85	44	18.13		
Distractors (D)	396.23	2	198.11	11.69	.01
G x D	77.11	2	38.55	2.18	-
I x D	188.49	2	94.24	5.54	.01
G x I x D	11.23	2	5.62	0.32	-
D x subjects within groups	1554.48	88	17.66		
Targets (T)	592.34	2	296.17	7.76	.01
G x T	81.41	2	40.71	1.10	-
I x T	123.58	2	61.79	1.66	-
G x I x T	107.67	2	53.83	1.44	-
T x subjects within groups	3306.84	88	37.12		

3.218

TABLE 3.6.17 (CONTD.)

Source	SS	df	MS	F	p
R x D	33.92	2	16.96	0.86	-
G x R x D	65.95	2	32.97	1.66	-
I x R x D	6.72	2	3.36	0.17	-
G x I x R x D	37.34	2	18.67	0.94	-
RD x subjects within groups	1745.40	88	19.83		
R x T	45.24	2	22.62	1.34	-
G x R x T	24.06	2	12.03	0.71	-
I x R x T	23.58	2	11.79	0.70	-
G x I x R x T	6.30	2	3.15	0.19	-
RT x subjects within groups	1481.44	88	16.82		
D x T	13.13	4	3.28	0.17	-
G x D x T	125.25	4	31.31	1.58	-
I x D x T	38.83	4	9.71	0.49	-
G x I x D x T	234.38	4	58.59	2.95	.05
DT x subjects within groups	3494.64	176	19.86		
R x D x T	63.55	4	15.89	1.05	-
G x R x D x T	40.82	4	10.21	0.48	-
I x R x D x T	73.80	4	18.45	1.22	-
G x I x R x D x T	5.60	4	1.40	0.09	-
RDT x subjects within groups	2656.86	176	15.10		
Total	23765.83	863			

TABLE 5.5.17 (CONTD.)

Source	SS	df	MS	F	P
R x D	38.92	2	16.96	0.86	-
G x R x D	63.89	2	31.97	1.62	-
I x R x D	6.72	2	3.36	0.17	-
G x I x R x D	37.34	2	18.67	0.94	-
RD x subjects within groups	1945.40	88	19.83		
R x T	45.84	2	22.92	1.34	-
G x R x T	24.05	2	12.02	0.71	-
I x R x T	23.08	2	11.79	0.70	-
G x I x R x T	6.30	2	3.15	0.19	-
RT x subjects within groups	1481.44	88	16.82		
D x T	13.13	4	3.28	0.17	-
G x D x T	125.25	4	31.31	1.58	-
I x D x T	36.83	4	9.21	0.46	-
G x I x D x T	234.38	4	58.59	2.95	.05
DT x subjects within groups	3494.64	176	19.86		
R x D x T	63.56	4	15.89	1.05	-
G x R x D x T	40.82	4	10.21	0.68	-
I x R x D x T	73.80	4	18.45	1.22	-
G x I x R x D x T	5.60	4	1.40	0.09	-
RDT x subjects within groups	2656.96	176	15.10		
Total	23765.23	863			

3.219

TABLE 3.6.18

SUMMARY OF ANOVA OBTAINED FOR CE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	14613.10	47			
Groups (G)	2066.63	1	2066.63	9.95	.01
Informations (I)	1512.75	1	1512.75	7.28	.01
G x I	1892.59	1	1892.59	9.11	.01
Subjects within groups	9141.13	44	207.75		
Within subjects	146606.63	816			
Retention Intervals(R)	126.62	1	126.62	5.99	.05
G x R	2.52	1	2.52	0.12	-
I x R	63.51	1	63.51	3.00	-
G x I x R	21.81	1	21.81	1.03	-
R x subjects within groups	930.27	44	21.14		
Distractors (D)	87.92	2	43.96	1.40	-
G x D	141.95	2	70.98	2.26	-
I x D	328.22	2	164.11	5.23	.01
G x I x D	188.88	2	94.44	3.01	-
D x subjects within groups	2762.41	88	31.39		
Targets (T)	77538.13	2	38769.06	214.57	.01
G x T	3140.13	2	1570.06	8.69	.01
I x T	24132.75	2	12066.38	66.78	.01
G x I x T	1321.69	2	660.84	3.66	.05
T x subjects within groups	15899.75	88	180.68		

TABLE 3.6.1B

SUMMARY OF ANOVA OBTAINED FOR GE SCORES OF CURVILINEAR TASK IN EXPERIMENT 3.6

Source	SS	df	MS	F	p
Between subjects	1461.10	47			
Groups (G)	2066.63	1	2066.63	6.88	.01
Informations (I)	1812.75	1	1812.75	7.38	.01
G x I	1892.89	1	1892.89	9.11	.01
Subjects within groups	9141.13	44	207.75		
Within subjects	14660.63	816			
Retention Intervals(R)	128.62	1	128.62	5.86	.05
G x R	5.82	1	5.82	0.13	-
I x R	63.51	1	63.81	3.00	-
G x I x R	21.81	1	21.81	1.03	-
R x subjects within groups	930.27	44	21.14		
Diatractors (D)	87.32	2	43.36	1.10	-
G x D	141.95	2	70.98	2.26	-
I x D	328.22	2	164.11	5.23	.01
G x I x D	188.88	2	94.44	3.01	-
D x subjects within groups	2762.41	88	31.39		
Targets (T)	77538.13	2	38769.06	214.37	.01
G x T	3140.13	2	1570.06	8.69	.01
I x T	24132.75	2	12066.32	66.74	.01
G x I x T	1321.69	2	660.84	3.65	.05
T x subjects within groups	15899.75	88	180.68		

3.220

TABLE 3.6.18 (CONTD.)

Source	SS	df	MS	F	p
R x D	161.50	2	80.75	3.53	.05
G x R x D	9.40	2	4.70	0.21	-
I x R x D	108.99	2	54.50	2.38	-
G x I x R x D	5.52	2	2.76	0.12	-
RD x subjects within groups	2011.66	88	22.86		
R x T	1121.75	2	560.88	16.76	.01
G x R x T	33.69	2	16.84	0.50	-
I x R x T	382.44	2	191.22	5.71	.01
G x I x R x T	11.56	2	5.78	0.16	-
RT x subjects within groups	2944.94	88	33.47		
D x T	856.94	4	214.23	7.30	.01
G x D x T	197.50	4	49.38	1.68	-
I x D x T	1136.31	4	284.08	9.68	.01
G x I x D x T	116.06	4	29.02	0.99	-
DT x subjects within groups	5164.82	176	29.35		
R x D x T	183.50	4	45.83	1.60	-
G x R x D x T	124.50	4	31.13	1.08	-
I x R x D x T	268.38	4	67.09	2.33	-
G x I x R x D x T	20.13	4	5.03	0.77	-
RDT x subjects within groups	5060.81	176	28.75		
Total		863			

TABLE 3.6.1g (CONTD.)

Source	SS	df	MS	F	P
R x D	161.50	2	80.75	3.53	.05
G x R x D	9.40	2	4.70	0.21	-
I x R x D	108.30	2	54.50	2.38	-
G x I x R x D	5.80	2	2.76	0.12	-
RD x subjects within groups	3011.00	82	22.86		
T x R	1121.75	2	560.88	16.76	.01
G x R x T	33.60	2	16.84	0.50	-
I x R x T	382.44	2	191.22	5.71	.01
G x I x R x T	11.56	2	5.78	0.16	-
RT x subjects within groups	2644.94	80	33.47		
D x T	856.94	4	214.23	7.30	.01
G x D x T	197.50	4	49.38	1.68	-
I x D x T	1136.31	4	284.08	9.68	.01
G x I x D x T	116.06	4	29.02	0.99	-
DT x subjects within groups	5164.82	176	29.35		
R x D x T	183.80	4	45.83	1.60	-
G x R x D x T	124.80	4	31.13	1.08	-
I x R x D x T	268.28	4	67.03	2.33	-
G x I x R x D x T	20.13	4	5.03	0.17	-
RDT x subjects within groups	5080.81	176	28.75		
Total		863			

3.221 Main effect of retention intervals was found significant in all the three error analyses: AE, $\underline{F}$ (1,44) = 60.88, $p < .01$; VE, $\underline{F}$ (1,44) = 16.72, $p < .01$; and CE, $\underline{F}$ (1,44) = 5.99, $p < .01$. Retention intervals of 20 sec. and 90 sec showed mean AE scores of 5.71° and 6.89°; mean VE scores of 5.71° and 6.89°; and mean CE scores of -2.39° and -1.63°, respectively. Delay in recall causes changes in both variability and constant error in reproduction of curvilinear movement.

Effect of distractors was significant only for AE, $\underline{F}$ (2,88) = 40.60, and VE, $\underline{F}$ (2,88) = 11.22, $p < .01$. The unfilled, counting and movement distractors yield mean AE scores of 5.37°, 6.95° and 6.59°; and mean VE scores of 5.37°, 6.95° and 6.59°, respectively. Again, movement and counting distractors were found to be more harmful than unfilled delay.

Main effect of targets is also significant in all the three error analyses: AE, $\underline{F}$ (2,88) = 52.65, $p < .01$; VE, $\underline{F}$ (2,88) = 7.89, $p < .01$; and CE, $\underline{F}$ (2,88) = 214.57, $p < .01$. Target conditions of 30° cm, 70° cm and 110° cm reflect mean AE scores of 5.20°, 7.20° and 6.50°; mean VE scores of 5.20°, 7.20° and 6.50°; and mean CE scores of 8.32°, 0.20° and -14.57°. Contrary to the reproduction of horizontal and vertical movements, middle 70° target revealed higher amount of AE and VE.

3.222 Among first order interaction effect a groups x information interaction effect is significant for CE data, F (1,44) = 9.11, $p < .01$. It shows that the groups differ strongly in underestimation of distance information; the blind group showing a stronger tendency to underestimate distance targets than the sighted.

A groups x targets interaction effect is significant for AE, F (2,88) = 7.43, $p < .01$; and CE, F (2,88) = 8.69, analysis. It revealed that sighted subjects show a consistent increase in AE with increase in target length, while blind subjects show a depression in their AE on middle 70° target. CE analysis also supported the general trends of data which was observed in both horizontal and vertical tasks. These results are similar to those observed in Experiment 3.5.

Second order groups x informations x retention intervals interaction effect is significant for only VE analysis, F (1,44) = 5.93, $p < .01$. The data generally supported the contention that retention intervals do not similarly affect the reproduction of the two informations by the sighted and blind subjects.

As true for the horizontal and vertical tasks the groups x informations x distractors interaction effect is significant for curvilinear task also in AE analysis, F (2,88) = 41.81, $p < .01$. The data of this task

3.223 consistently support the results of horizontal and vertical tasks. It reflects that location reproduction of both sighted and blind groups is hampered by interpolation of both counting and movement tasks but distance remains unaffected. Moreover, blind subjects show consistently poorer performance in distance reproduction than the sighted subjects.

A groups x informations x targets interaction effect was found significant in AE, $\underline{F}$ (2,88) = 6.17, $p < .01$ and CE, $\underline{F}$ (2,88) = 3.66, $p < .05$ analyses. It was revealed in AE analysis that the distinction in the performance of the groups was very strong in short and long distance reproductions, the blind being poorer than the sighted. On the middle distance target, on the contrary, performance of sighted was much poorer than the blind group. This finding is again consistent with the results of Experiment 3.5 and the previous two tasks of the present experiment. The results of previous experiment were also supported in CE analyses.

A consistently significant third order interaction of groups x informations x distractors x targets was found significant in VE analysis of this task, $\underline{F}$ (4,176) = 2.95, $p < .05$. This interaction effect shows that location and distance reproduction of blind and sighted groups is not affected similarly by distractors on short, middle and long targets. The major feature of the results is that blind subjects are more affected by movement distractor

3.224 than the sighted in location reproduction, particularly on short targets. In distance reproduction they remain unaffected. With a counting task interpolated in location reproduction, performance of the sighted subjects deteriorated more than the blind subjects on short targets, while on long targets reverse is true. Some effect of verbal distractor (counting) is noted on the blind in distance reproduction but sighted remained relatively unaffected by short targets. On long target, the reverse is true. This interaction effect is shown in Fig. 3.6.5.

An overall review of the findings in this experiment are reported below :

(1) The effect of distractors was clearly found in all the three tasks.

(2) Although an effect of groups x distractors was expected, no strong support was clearly available.

(3) In all the 3 tasks AE was found significant for groups x informations x distractors effect which means that some confounding effect of location and distance reproduction was existent. One reason for this may be the steep increase in recall errors of the blind subjects with lapse of time but this was not the case with the sighted subjects.

(4) The significant effect of groups x distractor x targets in AE analysis of horizontal and vertical tasks shows

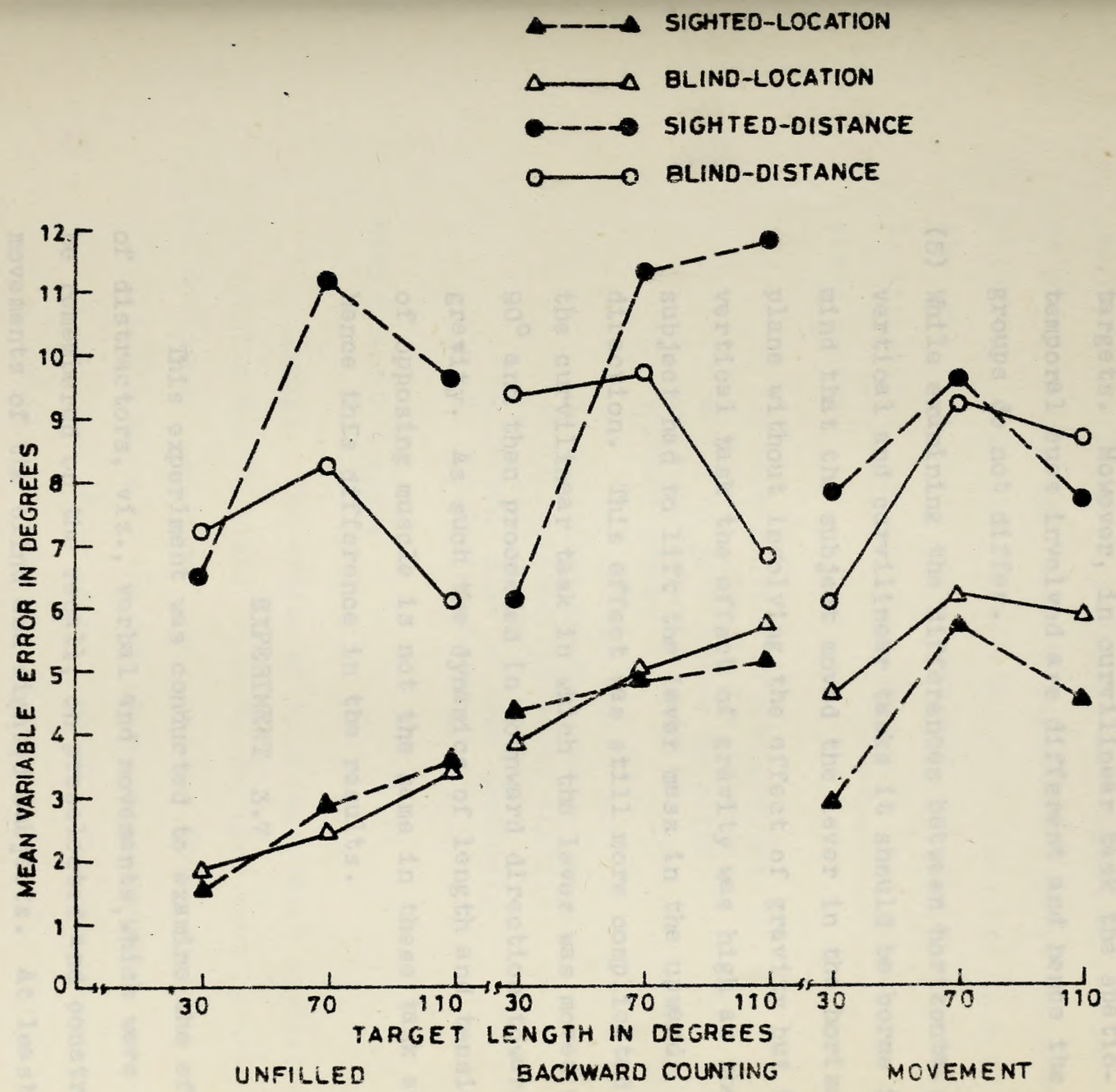


FIG.3.6.5 MEAN VARIABLE ERRORS OF SIGHTED AND BLIND SUBJECTS IN CURVILINEAR TASK AS A FUNCTION OF INFORMATIONS, DISTRACTORS AND TARGETS

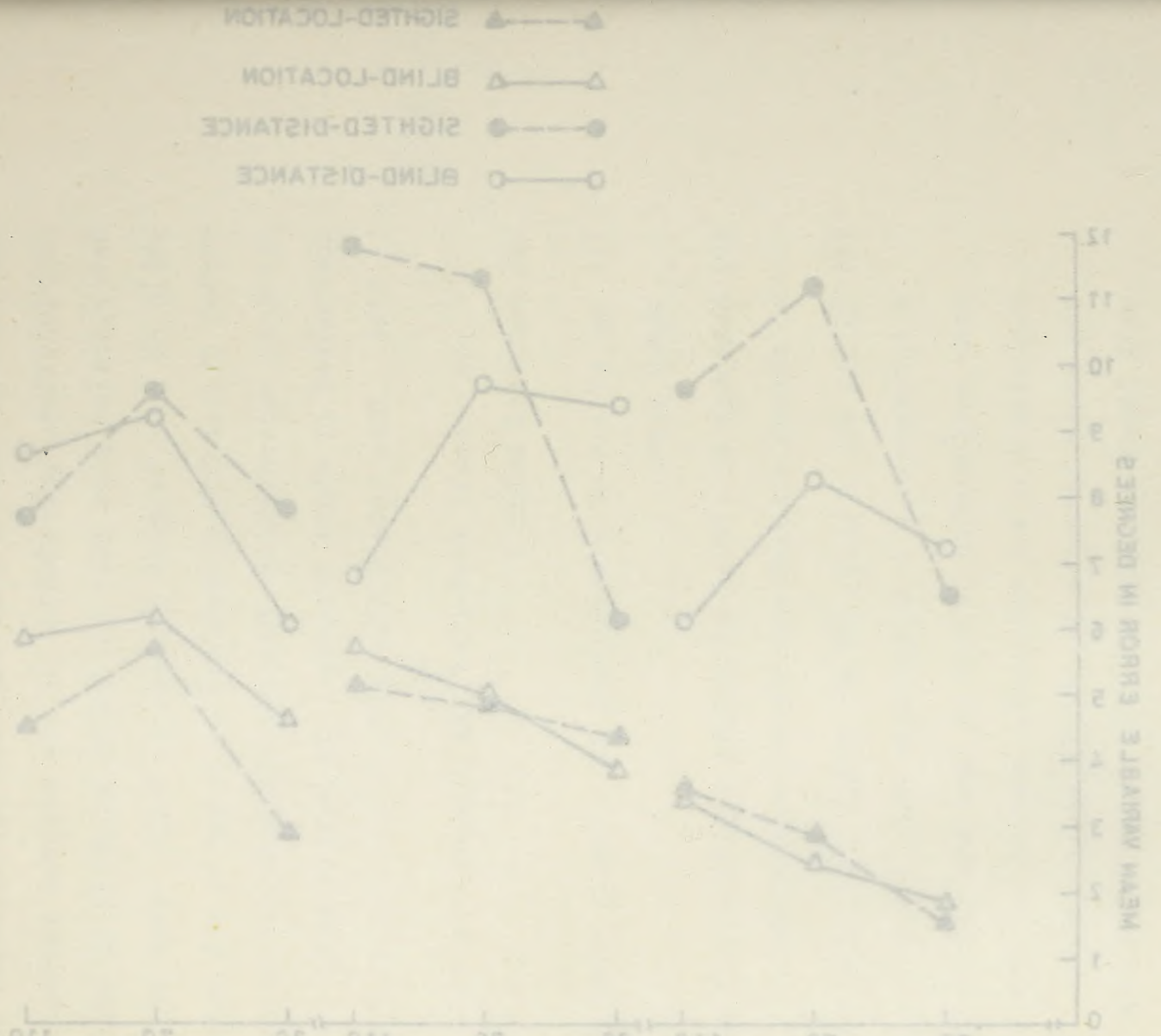


FIG. 3.8.5 MEAN VARIABLE ERRORS OF SIGHTED AND BLIND SUBJECTS IN CURVILINEAR TASK AS A FUNCTION OF INFORMATION, DISTRACTORS AND TARGETS

3.225 that when linear tasks are performed blind and sighted subjects differ in estimation of long and short targets. However, in curvilinear task the spatio-temporal cues involved are different and hence the two groups do not differ.

(5) While examining the differences between horizontal, vertical and curvilinear tasks it should be borne in mind that the subject moved the lever in the horizontal plane without involving the effect of gravity but in the vertical task the effect of gravity was high as the subject had to lift the lever mass in the upward direction. This effect was still more complicated in the curvilinear task in which the lever was moved upto 90° and then proceeded in downward direction towards the gravity. As such the dynamics of length and tension of opposing muscle is not the same in these task and hence this difference in the results.

EXPERIMENT 3.7

This experiment was conducted to examine the effect of distractors, viz., verbal and movements, which were not be remembered on the recall, on preselected and constrained movements of the blind and sighted subjects. At least in this way this experiment is different from the previous one in which no comparison was made between self selected and experimenter imposed targets. If capacity and structural

3.226 distractors have different effects in information processing it would be interesting to examine their effects when a subject is allowed to preselect his responses. This effort is particularly important to ascertain some of the effects which were found in preselected conditions and to scrutinize the extent to which structural and capacity distractors can be attenuated. Specific hypotheses in this connection are given below:

> In reproduction of preselected movement, effect of distractors would be more severe on blind subjects than those in the sighted group.

> On the other hand, in reproduction of constrained movement, sighted and blind subjects would be affected more or less similarly by the distractors.

Method and Procedure

Sample. The sample of this experiment consisted of 72 sighted and 72 blind subjects who were equally distributed on horizontal and curvilinear tasks. These subjects were righthanded males in the age range of 15 years to 25 years, with a mean age of 20 years 1 month. The blind subjects were selected from the schools and hostels for the blind located in Varanasi city of Uttar Pradesh. The blind and sighted groups were matched for their age, education and intelligence.

3.227 Apparatus. The apparatus used in this experiment were a Linear slide for horizontal movement and a Manual lever-D for the curvilinear movements, as described in the previous experiments.

Experimental Design and Procedure. A 2 x 2 x 3 x 3 within subjects factorial design having groups (sighted or blind), preselection (preselected or constrained), targets (5 cm to 20 cm, 20 cm to 35 cm or 35 cm to 50 cm) and distractors (unfilled - 20 sec, counting - 20 sec or movement - 20 sec), was employed for horizontal and curvilinear tasks (Fig. 3.7.1). A fresh set of 18 subjects was assigned for the 4 subgroups, i.e., sighted-preselected, sighted-constrained, blind-preselected and blind-constrained. Each subject received 5 trials of each of 9 experimental treatments (3 sectors x 3 interpolated activities). All 45 trials were distributed in 3 sessions of the experiments with an intertrial interval of 1 minute.

The general procedure regarding laboratory setting and instruction to subjects remained the same. In this experiment no attempt was made to isolate location or the distance information but only a simple reproduction of the movement reproduction of the movement was demanded.

The procedure for studying preselected and constrained movements remained the same as described in Experiment 3.5.

		$b_1 d_1$	$b_1 d_2$	$b_1 d_3$	$b_2 d_1$	$b_2 d_2$	$b_2 d_3$	$b_3 d_1$	$b_3 d_2$	$b_3 d_3$	
		T 5	5	5	5	5	5	5	5	5	n
a_1	c_1	S_1	S_1	S_1	S_1	S_1	S_1	S_1	S_1	S_1	18
a_1	c_2	S_2	S_2	S_2	S_2	S_2	S_2	S_2	S_2	S_2	18
a_2	c_1	S_3	S_3	S_3	S_3	S_3	S_3	S_3	S_3	S_3	18
a_2	c_2	S_4	S_4	S_4	S_4	S_4	S_4	S_4	S_4	S_4	18

a- GROUPS
1) SIGHTED
2) BLIND

b - DISTRACTORS
1) UNFILLED-20 Sec
2) COUNTING-20 Sec
3) MOVEMENT-20 Sec

c - PRESELECTED
1) PRESELECTED
2) CONSTRAINED

e - TARGETS
1) SHORT- 0 cm-15 cm / 0°- 50°
2) MIDDLE 15 cm - 30 cm / 50°- 100°
3) LONG 30 cm - 45 cm / 100°- 150°

FIG.3.7.1 DESIGN OF EXPERIMENT 3.7



3.228 Interpolated activities involved either backward counting by 3s or movements in a circle for the given period of retention interval.

Dependent Variable. Reproduction responses of the subjects were recorded in terms of AE, VE and CE.

Results and Discussion

Horizontal Task. Appendices 3.XXX, 3.XXXI and 3.XXXII report AE, VE and CE raw scores obtained by blind and sighted subjects, respectively. Tables 3.7.1, 3.7.2 and 3.7.3 report means and S.D. of blind and sighted groups in different experimental treatment conditions. Significance of the mean differences were examined using a 2 x 2 x 3 x 3 within subject factorial design separately for AE, VE and CE. A summary of these results is reported in Tables 3.7.4, 3.7.5 and 3.7.6, respectively.

Main effect of groups was found significant only in CE analysis, F (1,68) = 17.08, $p < .01$. Sighted subjects (0.30 cm) were found to overestimate the targets, while blind subjects (-0.34 cm) tended to underestimate. The differences between the mean of the blind and sighted were not significant in AE and VE analysis.

Preselection was found to be a significant factor in AE, F (1,68) = 88.86, $p < .01$ and VE, F (1,68) = 17.46, $p < .01$, analyses. For preselected and constrained movement

3.229

TABLE 3.7.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractor	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0-15 cm	Filled	1.22 (0.53)	2.79 (0.90)	1.88 (0.99)	2.67 (0.93)
	Unfilled	1.01 (0.47)	1.32 (0.49)	0.85 (0.26)	1.35 (0.34)
	Movement	1.45 (0.73)	2.97 (0.82)	1.77 (0.71)	2.46 (0.62)
15-30 cm	Filled	1.47 (0.53)	3.46 (0.54)	2.44 (1.02)	2.89 (0.87)
	Unfilled	1.47 (0.70)	1.68 (0.46)	1.09 (0.40)	1.48 (0.54)
	Movement	1.77 (0.91)	3.49 (0.87)	2.42 (0.73)	2.42 (0.99)
30-45 cm	Filled	2.45 (1.04)	2.46 (0.76)	3.17 (0.92)	4.14 (1.41)
	Unfilled	2.26 (0.85)	2.47 (0.70)	1.85 (0.56)	2.53 (0.91)
	Movement	2.17 (0.87)	3.83 (0.83)	2.91 (1.12)	3.55 (0.85)

TABLE 3.7.1

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF RIGHT AND EIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESENTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets.	Distractor	Eighted		Right	
		Pre-selected	Constrained	Pre-selected	Constrained
0-15 cm	Filled	1.25 (0.53)	2.79 (0.60)	1.88 (0.99)	3.65 (0.89)
	Unfilled	1.01 (0.47)	1.72 (0.49)	0.88 (0.78)	1.86 (0.52)
	Movement	1.45 (0.73)	2.92 (0.82)	1.72 (0.71)	2.68 (0.89)
15-30 cm	Filled	1.47 (0.85)	3.46 (0.54)	2.44 (1.02)	3.86 (0.77)
	Unfilled	1.47 (0.90)	1.68 (0.46)	1.04 (0.40)	1.68 (0.54)
	Movement	1.77 (0.81)	3.49 (0.87)	2.42 (0.99)	3.16 (0.80)
30-45 cm	Filled	2.45 (1.04)	3.16 (0.76)	2.77 (0.82)	4.16 (1.44)
	Unfilled	2.36 (0.85)	2.47 (0.90)	1.88 (0.86)	2.88 (0.84)
	Movement	2.17 (0.89)	3.83 (0.83)	2.01 (1.18)	3.68 (0.88)

3.230

TABLE 3.7.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Constrained	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0-15 cm	Filled	1.09 (0.51)	1.66 (0.92)	1.31 (0.89)	1.56 (0.69)
	Unfilled	1.00 (0.49)	0.81 (0.40)	0.83 (0.30)	0.97 (0.36)
	Movement	1.21 (0.57)	1.37 (0.75)	1.30 (0.50)	1.16 (0.53)
15-30 cm	Filled	1.48 (0.64)	2.85 (0.93)	2.43 (0.94)	2.59 (1.04)
	Unfilled	1.49 (0.87)	1.46 (0.48)	1.14 (0.41)	1.43 (0.64)
	Movement	1.77 (1.15)	2.58 (1.04)	2.42 (0.71)	2.19 (1.22)
30-45 cm	Filled	1.95 (1.09)	3.18 (1.31)	2.39 (1.37)	2.62 (1.32)
	Unfilled	2.10 (0.84)	1.90 0.61)	1.22 (0.61)	1.47 (0.76)
	Movement	1.80 (0.68)	3.20 (1.30)	2.07 (0.95)	2.16 (0.72)

3.230

TABLE 3.7.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Constrained	SIGHTED		BLIND	
		Pre-selected	Constrained	Pre-selected	Constrained
0-15 cm	Filled	1.09 (0.51)	1.65 (0.92)	1.31 (0.89)	1.39 (0.89)
	Unfilled	1.03 (0.49)	0.81 (0.40)	0.83 (0.30)	0.97 (0.35)
	Movement	1.21 (0.57)	1.37 (0.75)	1.30 (0.50)	1.19 (0.55)
15-30 cm	Filled	1.48 (0.84)	2.86 (0.93)	2.43 (0.94)	2.59 (1.04)
	Unfilled	1.49 (0.87)	1.46 (0.48)	1.14 (0.41)	1.43 (0.64)
	Movement	1.77 (1.18)	3.58 (1.04)	3.42 (0.71)	3.19 (1.28)
30-45 cm	Filled	1.85 (1.09)	3.18 (1.31)	2.39 (1.37)	2.52 (1.39)
	Unfilled	2.10 (0.94)	1.90 (0.61)	1.52 (0.61)	1.47 (0.95)
	Movement	1.80 (0.88)	3.20 (1.30)	2.07 (0.95)	2.13 (0.72)

.231

TABLE 3.7.3

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0-15 cm	Filled	0.73 (0.65)	2.17 (1.34)	1.37 (1.41)	2.19 (1.32)
	Unfilled	0.08 (0.74)	0.62 (1.05)	0.41 (0.45)	0.97 (0.68)
	Movement	1.13 (0.82)	2.66 (1.21)	1.39 (1.02)	2.28 (0.87)
15-30 cm	Filled	-0.14 (0.77)	0.68 (2.26)	-0.08 (1.44)	-0.37 (1.91)
	Unfilled	-0.03 (1.22)	0.02 (1.15)	0.10 (0.50)	0.06 (0.79)
	Movement	0.49 (1.06)	1.22 (2.43)	-0.20 (1.41)	-0.39 (1.51)
30-45 cm	Filled	-1.27 (1.80)	-1.55 (2.86)	-2.05 (1.52)	-3.32 (1.95)
	Unfilled	-0.47 (1.63)	-1.42 (1.26)	-1.34 (0.91)	-1.93 (1.38)
	Movement	0.28 (1.82)	0.13 (2.42)	-2.13 (1.38)	-3.04 (1.07)

TABLE 3.7.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF SIGHTED AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		SIGHTED	
		Pre-selected	Constrained	Pre-selected	Constrained
0-15 cm	Filled	0.73 (0.65)	2.17 (1.34)	1.37 (1.41)	2.10 (1.52)
	Unfilled	0.08 (0.74)	0.62 (1.05)	0.41 (0.45)	0.07 (0.89)
	Movement	1.15 (0.82)	2.66 (1.21)	1.39 (1.72)	2.88 (0.87)
15-30 cm	Filled	-0.14 (0.77)	0.68 (2.36)	-0.08 (1.44)	-0.32 (1.80)
	Unfilled	-0.03 (1.22)	0.02 (1.16)	0.10 (0.85)	0.02 (0.76)
	Movement	0.49 (1.06)	1.22 (2.45)	-0.60 (1.41)	-0.32 (1.81)
30-45 cm	Filled	-1.27 (1.80)	-1.35 (2.86)	-2.05 (1.82)	-3.32 (1.26)
	Unfilled	-0.47 (1.63)	-1.42 (1.36)	-1.34 (0.91)	-1.02 (1.38)
	Movement	0.88 (1.82)	0.15 (2.46)	-2.13 (0.38)	-3.04 (1.07)

3.232

TABLE 3.7.4

SUMMARY OF ANOVA OBTAINED FOR AE ON HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	246.68	71			
Groups (G)	0.06	1	0.06	0.04	-
Preselection (P)	129.73	1	129.03	88.86	.01
G x P	17.46	1	17.46	11.96	.01
Subjects within groups	99.43	68	1.46		
Within subjects	658.27	576			
Targets (T)	150.60	2	75.30	127.63	.01
G x T	1.30	2	0.65	1.10	-
P x T	1.14	2	0.57	0.97	-
G x P x T	2.79	2	1.40	2.37	-
T x subjects within groups	80.30	136	0.59		
Distractors (D)	162.85	2	81.43	131.34	.01
G x D	5.28	2	2.64	4.26	.05
P x D	22.62	2	11.31	18.24	.01
G x P x D	17.89	2	8.95	13.85	.01
D x subjects within groups	83.92	136	0.62		
T x D	3.89	4	0.97	2.16	-
G x T x D	1.08	4	0.27	0.60	-
P x T x D	0.42	4	0.11	0.24	
G x P x T x D	1.00	4	0.25	0.56	-
TD x subjects within groups	123.19	272	0.45		
Total	904.95	647			

TABLE 3.7.4

SUMMARY OF ANOVA OBTAINED FOR AS ON HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	246.68	71			
Groups (G)	0.06	1	0.06	0.04	-
Preselection (P)	129.73	1	129.73	88.86	.01
G x P	17.46	1	17.46	11.96	.01
Subjects within groups	99.43	68	1.46		
Within subjects	688.87	576			
Targets (T)	150.60	2	75.30	127.63	.01
G x T	1.30	2	0.65	1.10	-
P x T	1.14	2	0.57	0.97	-
G x P x T	2.76	2	1.40	2.37	-
T x subjects within groups	80.30	136	0.59		
Distractors (D)	162.85	2	81.43	131.39	.01
G x D	5.28	2	2.64	4.26	.05
P x D	22.62	2	11.31	18.24	.01
G x P x D	17.80	2	8.90	14.36	.01
D x subjects within groups	83.98	136	0.62		
T x D	3.80	4	0.97	3.16	-
G x T x D	1.08	4	0.27	0.88	-
P x T x D	0.42	4	0.11	0.34	-
G x P x T x D	1.00	4	0.25	0.80	-
TD x subjects within groups	123.10	272	0.45		
Total	904.85	647			

3.233

TABLE 3.7.5

SUMMARY OF ANOVA OBTAINED FOR VE ON HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	102.98	71			
Groups (G)	1.34	1	1.34	1.23	-
Preselection (P)	19.03	1	19.03	17.96	.01
G x P	8.25	1	8.25	7.57	.01
Subjects within groups	74.36	68	1.09		
Within subjects	605.27	576			
Targets (T)	117.49	2	58.75	90.38	.01
G x T	6.35	2	3.18	4.89	.01
P x T	3.89	2	1.95	3.00	-
G x P x T	2.66	2	1.33	2.05	-
T x subjects within groups	87.76	136	0.65		
Distractors (D)	72.09	2	36.05	56.33	.01
G x D	4.28	2	2.14	3.34	.05
P x D	9.53	2	4.77	7.45	.01
G x P x D	13.73	2	6.87	10.73	.01
D x subjects within groups	86.60	136	0.64		
T x D	5.99	4	1.50	2.17	-
G x T x D	1.65	4	0.41	0.59	-
P x T x D	1.62	4	0.66	0.96	-
G x P x T x D	1.87	4	0.47	0.68	-
TD x subjects within groups	188.78	272	0.69		
Total	708.25	647			

TABLE 3.7.5

SUMMARY OF ANOVA OBTAINED FOR VE OF HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	109.98	71			
Groups (G)	1.34	1	1.34	1.23	-
Preselection (P)	19.03	1	19.03	17.66	.01
G x P	8.85	1	8.85	7.87	.01
Subjects within groups	74.36	68	1.09		
Within subjects	605.27	576			
Targets (T)	117.49	2	58.75	60.32	.01
G x T	6.35	2	3.18	4.89	.01
P x T	3.89	2	1.96	3.00	-
G x P x T	3.66	2	1.33	2.05	-
T x subjects within groups	87.76	136	0.65		
Distances (D)	72.09	2	36.05	86.33	.01
G x D	4.28	2	2.14	5.34	.05
P x D	6.53	2	4.77	7.45	.01
G x P x D	13.73	2	6.87	10.78	.01
D x subjects within groups	86.60	136	0.64		
T x D	8.36	4	1.50	2.17	-
G x T x D	1.65	4	0.41	0.59	-
P x T x D	1.82	4	0.46	0.66	-
G x P x T x D	1.87	4	0.47	0.68	-
TD x subjects within groups	188.78	272	0.69		
Total	708.25	647			

3.234

TABLE 3.7.6

SUMMARY OF ANOVA OBTAINED FOR CE ON HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	339.31	71			
Groups (G)	65.09	1	65.09	17.08	.01
Preselection (P)	3.79	1	13.79	0.99	-
G x P	11.27	1	11.27	2.96	-
Subjects within groups	259.16	68	3.81		
Within subjects	2249.16	576			
Targets (T)	878.91	2	439.46	158.08	.01
G x T	87.44	2	43.72	15.73	.01
P x T	73.74	2	36.87	13.26	.01
G x P x T	0.66	2	0.33	0.12	-
T x subjects within groups	378.63	136	2.78		
Distractors (D)	38.41	2	19.21	8.54	.01
G x D	43.53	2	21.77	9.68	.01
P x D	4.36	2	2.18	0.97	-
G x P x D	8.01	2	4.00	1.78	-
D x subjects within groups	306.02	136	2.25		
T x D	69.57	4	17.39	13.80	.01
G x T x D	14.20	4	3.55	2.82	.05
P x T x D	1.92	4	0.48	0.38	-
G x P x T x D	0.63	4	0.16	0.13	-
TD x subjects within groups	343.13	272	1.26		
Total	2588.47	647			

TABLE 3.7.6

SUMMARY OF ANOVA OBTAINED FOR DE ON HORIZONTAL TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	339.31	71			
Groups (G)	65.09	1	65.09	17.08	.01
Preselection (P)	3.78	1	13.79	0.99	-
G x P	11.27	1	11.27	2.96	-
Subjects within groups	259.16	68	3.81		
Within subjects	2249.16	576			
Targets (T)	878.91	2	439.46	188.06	.01
G x T	87.44	2	43.72	18.73	.01
P x T	73.74	2	36.87	15.36	.01
G x P x T	0.86	2	0.35	0.15	-
T x subjects within groups	378.65	136	2.78		
Directions (D)	36.41	2	18.21	8.36	.01
G x D	43.85	2	21.77	9.98	.01
P x D	4.36	2	2.18	0.97	-
G x P x D	8.01	2	4.00	1.78	-
D x subjects within groups	306.02	136	2.25		
T x D	69.17	4	17.29	13.80	.01
G x T x D	14.20	4	3.65	2.82	.05
P x T x D	1.92	4	0.48	0.38	-
G x P x T x D	0.63	4	0.16	0.13	-
TD x subjects within groups	343.13	272	1.26		
Total	2988.47	647			

3.235 conditions mean AE are 1.87 cm and 2.76 cm and mean VE errors are 1.61 cm and 1.95 cm, respectively. These mean scores show that recall of preselected movements are more consistent and less variable than the constrained movements.

As previously reported in other experiments target length was found to be a significant factor in movement recall in all 3 error analyses: AE, F (2,136) = 127.63, $p < .01$; VE, F (2,136) = 90.38, $p < .01$; and CE, F (2,136) = 158.06; $p < .01$. For short, middle and long sectors mean AE scores are 0.55 cm, 2.17 cm and 2.97 cm, mean VE scores are 1.19 cm, 1.99 cm and 2.17 cm, and mean CE scores are 1.33 cm, 0.11 cm and -1.51 cm, respectively. These results indicate that with increase in length of targets the subjects show a tendency of increasing variability and underestimation in the recall responses.

Main effect of interpolated activities was also found significant in all three error analyses: AE, F (2,136) = 131.34, $p < .01$; VE, F (2,136) = 56.33, $p < .01$; and CE, F (2,136) = 8.54, $p < .01$. For unfilled verbal and movement distractor conditions mean AE scores are 1.61 cm, 2.74 cm and 2.60 cm; mean VE errors are 1.32 cm, 2.09 cm and 1.94 cm; and mean CE scores are -0.29 cm, -0.14 cm and 0.32 cm, respectively. These results suggest the hampering effect of both verbal and movement interpolated activity on the recall of movement. As a result of verbal activity movements

3.236 are underestimated but with movement interpolation overestimation takes place.

Several first order interaction effects were found statistically significant. A groups x preselection interaction is significant for AE, F (1,68) = 11.96, $p < .01$, and VE, F (1,68) = 7.57, $p < .01$. It indicates that the blind subjects perform poorer than the sighted subjects in reproduction of preselected movements, while the reverse is true for constrained movements.

A group x targets interaction is significant for VE, F (2,136) = 4.89, $p < .01$, and CE, F (1,136) = 15.73, $p < .01$. This interaction effect suggests that recall pattern of blind and sighted subjects is not identical for long and short targets.

A groups x distractors interactions effect is significant for AE, F (2,136) = 4.26, $p < .01$; VE, F (2,136) = 3.34, $p < .05$, and CE, F (2,136) = 9.68, $p < .01$. It is observed that when the interval is unfilled blind subjects seem to do better than the sighted subjects. When verbal distractor is interpolated between learning and recall blind subjects seem to be affected more than the sighted. This pattern reverses for the condition where interpolated activity is movement. It is observed from the constant error data that interpolated activities cause positive biasing in the sighted subjects but negative biasing in the blind subjects.

3.237 An interesting third order groups x preselection x interpolated activity interaction is significant only for AE, $\underline{F}$ (2,136) = 13.85, $p < .01$, and VE, $\underline{F}$ (2,136) = 10.73, $p < .01$. This interaction effect ~~(see Fig. 3.7.2)~~ indicates that the sighted subjects are affected by interpolated verbal and movement distractors in reproduction of constrained movements but not in reproduction of preselected movements. The blind subjects, on the contrary, are affected by verbal and movement distractors in reproduction of both preselected and constrained movements.

A groups x targets x distraction interaction is also significant for CE, $\underline{F}$ (4,272) = 2.82, $p < .01$ only. This interaction effect suggests that distractors cause different pattern of response biasing in reproduction of short and long targets of blind and sighted subjects.

A general picture of reproduction responses that emerges from this experiment regarding the horizontal task is that in reproduction of simple constrained movement the blind subject may perform better than their sighted counterpart probably because of their long experience and heavy reliance on their kinesthetic modality. Moreover, the sighted subjects are affected by various distractors only in constrained condition. If preselection cue is available to the subjects the sighted subjects can escape from being affected by these distractors. The blind subjects,

3.238 on the other hand, seem to be unable to use preselection successfully and they are affected by the distractors in reproduction of both preselected and constrained movements.

Curvilinear Task. Appendices 3.XXXIII, 3.XXXIV and 3.XXXV present the raw AE, VE and CE scores of each subjects. Tables 3.7.7, 3.7.8 and 3.7.9 show means and S.D. of the groups in various experimental conditions for AE, VE and CE. These mean scores were subjected to an ANOVA test performed separately for each of the three response measures and a summary of these three tests is presented in Tables 3.7.10, 3.7.11, and 3.7.12, separately.

In these analyses of the reproduction errors for curvilinear task main effect of preselection is significant for AE, F (1,68) = 31.50, $p < .01$, and VE, F (1,68) = 13.12, $p < .01$. For preselected and constrained movements mean AE scores are 5.07° and 6.37°, and mean VE scores are 4.44° and 5.51°. These results confirm findings reported in earlier experiments of this series that recall responses for preselected movement are more consistent than constrained movements.

Main effect of target length is significant for all three response measures: AE, F (2,136) = 52.67, $p < .01$; VE, F (2,136) = 48.96, $p < .01$, and CE, F (2,136) = 117.44, $p < .01$. For short, middle and long targets mean AE scores

3.239

TABLE 3.7.7

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED CURVILINEAR MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0°-50°	Filled	3.48 (1.53)	6.97 (3.15)	5.39 (2.19)	6.36 (1.83)
	Unfilled	2.91 (1.27)	3.17 (1.12)	2.39 (1.23)	4.47 (1.59)
	Movement	4.08 (1.79)	6.63 (2.92)	4.49 (1.82)	6.54 (2.15)
50°-100°	Filled	4.36 (1.34)	8.42 (2.86)	6.02 (2.00)	7.43 (3.48)
	Unfilled	3.96 (1.50)	4.87 (1.11)	3.66 (1.15)	5.74 (1.92)
	Movement	5.39 (4.44)	7.63 (2.44)	6.51 (2.42)	7.76 (2.55)
100°-150°	Filled	6.21 (2.59)	10.44 (3.48)	7.98 (2.85)	8.58 (3.62)
	Unfilled	5.71 (2.29)	5.62 (2.18)	5.18 (1.75)	7.51 (2.74)
	Movement	5.87 (2.54)	9.71 (4.13)	7.67 (2.56)	7.57 (3.24)

TABLE 3.7.7

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PREARRANGED AND CONSTRAINED CURVILINEAR MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0°-50°	Filled	3.48 (1.83)	6.97 (3.15)	5.39 (2.19)	8.36 (1.83)
	Unfilled	2.91 (1.27)	3.17 (1.12)	2.39 (1.23)	4.47 (1.89)
	Movement	4.08 (1.79)	6.63 (2.62)	4.49 (1.82)	6.64 (2.15)
50°-100°	Filled	4.36 (1.34)	8.42 (2.86)	6.02 (2.00)	7.43 (3.46)
	Unfilled	3.09 (1.50)	4.87 (1.11)	3.66 (1.15)	6.74 (1.92)
	Movement	5.39 (4.44)	7.63 (2.44)	6.81 (2.43)	7.96 (2.56)
100°-150°	Filled	6.21 (2.59)	10.44 (3.48)	7.98 (2.88)	8.38 (3.28)
	Unfilled	6.71 (2.29)	8.62 (2.18)	6.12 (1.75)	7.61 (2.74)
	Movement	6.87 (2.84)	9.71 (4.13)	7.67 (2.69)	9.07 (3.84)

3.240

TABLE 3.7.8

MEAN AND S.D. (GIVEN IN BRACKETS) OF VE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTED AND CONSTRAINED CURVILINEAR MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0° - 50°	Filled	3.18 (1.37)	4.24 (2.98)	4.00 (1.85)	4.29 (2.16)
	Unfilled	2.79 (1.41)	2.91 (1.37)	2.37 (1.13)	3.94 (1.60)
	Movement	3.78 (1.56)	4.01 (2.31)	4.32 (1.43)	4.66 (1.77)
50° - 100°	Filled	4.45 (1.19)	7.82 (3.06)	4.67 (1.71)	5.60 (2.95)
	Unfilled	3.79 (1.57)	4.28 (1.36)	3.36 (1.57)	5.65 (2.14)
	Movement	6.11 (6.51)	6.91 (2.90)	5.68 (2.08)	6.75 (2.54)
100° - 150°	Filled	5.56 (2.27)	8.16 (3.48)	6.24 (2.34)	5.73 (2.27)
	Unfilled	4.68 (2.14)	5.21 (1.98)	3.88 (1.72)	6.30 (2.75)
	Movement	5.63 (2.14)	7.11 (3.83)	5.44 (2.76)	5.64 (2.66)

3.241

TABLE 3.7.9

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE SCORES OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF PRESELECTION AND CONSTRAINED CURVILINEAR MOVEMENTS AS A FUNCTION OF TARGETS AND DISTRACTORS

Targets	Distractors	SIGHTED		BLIND	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
0° - 50°	Filled	1.54 (2.03)	5.03 (3.60)	3.48 (3.14)	4.62 (2.94)
	Unfilled	0.49 (2.18)	1.19 (1.92)	1.12 (1.64)	2.00 (2.77)
	Movement	2.17 (2.62)	3.83 (4.77)	1.98 (2.85)	4.10 (4.14)
50°-100°	Filled	-0.47 (2.71)	0.64 (4.73)	-1.84 (4.54)	-3.83 (5.20)
	Unfilled	-0.87 (2.39)	-0.49 (3.49)	-0.28 (2.84)	-0.88 (2.89)
	Movement	1.39 (4.92)	-1.30 (4.33)	-3.16 (3.43)	-2.51 (4.85)
100°-150°	Filled	-2.94 (3.84)	0.02 (7.68)	-4.36 (4.81)	-5.69 (5.81)
	Unfilled	-3.60 (2.88)	-2.49 (3.14)	-1.91 (4.09)	-3.33 (4.23)
	Movement	-2.58 (3.56)	-5.11 (6.08)	-4.42 (4.72)	-4.43 (4.51)

3.242

TABLE 3.7.10

SUMMARY OF ANOVA OBTAINED FOR AE ON CURVILINEAR TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	1901.80	71			
Groups (G)	16.89	1	16.89	0.91	-
Preselection (P)	589.44	1	589.44	31.50	.01
G x P	39.01	1	39.01	2.10	-
Subjects within groups	1261.46	68	18.55		
Within subjects	4154.50	576			
Targets (T)	729.55	2	364.79	52.67	.01
G x T	2.38	2	1.19	0.17	-
P x T	0.98	2	0.49	0.07	-
G x P x T	12.22	2	6.11	0.88	-
T x subjects within groups	941.83	136	6.93		
Distractors (D)	655.77	2	327.89	72.86	.01
G x D	1.67	2	0.83	0.19	-
P x D	39.21	2	19.61	4.36	.05
G x P x D	166.00	2	83.00	18.44	.01
D x subjects within groups	612.01	136	4.50		
T x D	15.15	4	3.79	1.10	-
G x T x D	9.25	4	2.31	0.67	-
P x T x D	6.07	4	1.52	0.44	-
G x P x T x D	25.75	4	6.44	1.87	-
TD x subjects within groups	936.66	272	3.44		
Total	6056.30	647			

TABLE 5.7.10

SUMMARY OF ANOVA OBTAINED FOR AS ON CURVILINEAR TASK IN EXPERIMENT 5.7

Source	SS	df	MS	F	p
Between subjects	1801.50	71			
Groups (G)	16.89	1	16.89	0.91	-
Preselection (P)	889.44	1	889.44	31.90	.01
G x P	39.01	1	39.01	2.10	-
Subjects within groups	1361.46	68	18.65		
Within subjects	4154.50	576			
Targets (T)	728.85	2	364.79	82.87	.01
G x T	2.38	2	1.19	0.47	-
P x T	0.98	2	0.49	0.09	-
G x P x T	12.22	2	6.11	0.88	-
T x subjects within groups	941.83	136	6.93		
Distractors (D)	656.77	2	327.89	72.86	.01
G x D	1.67	2	0.83	0.19	-
P x D	39.21	2	19.61	4.36	.05
G x P x D	166.00	2	83.00	18.44	.01
D x subjects within groups	612.01	136	4.50		
T x D	15.39	4	3.85	1.10	-
G x T x D	8.85	4	2.21	0.67	-
P x T x D	6.07	4	1.52	0.44	-
G x P x T x D	25.75	4	6.44	1.87	-
TD x subjects within groups	936.56	272	3.44		
Total	6056.36	647			

3.243

TABLE 3.7.11

SUMMARY OF ANOVA OBTAINED FOR VE ON CURVILINEAR TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	1157.35	71			
Groups (G)	2.28	1	2.28	0.16	-
Preselection (P)	186.50	1	186.50	13.12	.01
G x P	2.07	1	2.07	0.15	-
Subjects within group	966.49	68	14.21		
Within subjects	3751.55	576			
Targets (T)	539.74	2	269.87	48.96	.01
G x T	26.76	2	13.38	2.43	-
P x T	21.27	2	10.63	1.93	-
G x P x T	8.62	2	4.31	0.78	-
T x subjects within group	749.60	136	5.51		
Distractors (D)	255.75	2	127.88	25.19	.01
G x D	16.54	2	8.27	1.63	-
P x D	12.32	2	6.16	1.21	-
G x P x D	99.81	2	49.90	9.83	.01
D x subjects within group	690.30	136	5.08		
T x D	38.06	4	9.51	2.06	-
G x T x D	15.84	4	3.96	0.86	-
P x T x D	8.22	4	2.06	0.44	-
G x P x T x D	11.36	4	2.84	0.61	-
TD x subjects within groups	1257.37	272	4.62		
Total	4908.90	647			

TABLE 3.7.11

SUMMARY OF ANOVA OBTAINED FOR VS OF CURVILINEAR TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	1157.35	71			
Groups (G)	6.28	1	2.28	0.16	-
Preselection (P)	186.80	1	186.80	13.12	.01
G x P	2.07	1	2.07	0.15	-
Subjects within group	986.49	68	14.21		
Within subjects	3751.65	576			
Targets (T)	830.74	2	389.87	48.96	.01
G x T	26.76	2	13.38	2.45	-
P x T	21.27	2	10.65	1.95	-
G x P x T	8.62	2	4.31	0.78	-
T x subjects within group	749.60	136	5.51		
Distractors (D)	255.75	2	127.88	25.19	.01
G x D	16.54	2	8.27	1.65	-
P x D	12.32	2	6.16	1.21	-
G x P x D	99.81	2	49.90	9.83	.01
D x subjects within group	690.30	136	5.08		
T x D	38.06	4	9.51	2.06	-
G x T x D	15.84	4	3.96	0.85	-
P x T x D	8.22	4	2.06	0.44	-
G x P x T x D	11.35	4	2.84	0.61	-
TD x subjects within groups	1257.37	272	4.62		
Total	4908.20	647			

3.244

TABLE 3.7.12

SUMMARY OF ANOVA OBTAINED FOR CE ON CURVILINEAR TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	2900.92	71			
Groups (G)	125.00	1	125.00	3.11	-
Preselection (P)	15.87	1	15.87	0.39	-
G x P	22.89	1	22.89	0.57	-
Subjects within group	2737.16	68	40.25		
Within subjects	12266.54	576			
Targets (T)	4011.32	2	2005.66	117.44	.01
G x T	167.36	2	83.68	4.90	.01
P x T	151.20	2	75.60	4.43	.05
G x P x T	10.21	2	5.10	0.30	-
T x subjects within group	2322.64	136	17.08		
Distractors (D)	33.88	2	16.94	1.14	-
G x D	151.41	2	75.71	5.11	.01
P x D	30.29	2	15.14	1.02	-
G x P x D	195.95	2	97.97	6.62	.01
D x subjects within groups	2013.15	136	14.80		
T x D	293.52	4	73.38	7.41	.01
G x T x D	117.22	4	29.31	2.96	.05
P x T x D	39.12	4	9.78	0.99	-
G x P x T x D	35.02	4	8.75	0.88	-
TD x subjects within groups	2694.26	272	9.91		
Total	15167.46	647			

TABLE 3.7.12

SUMMARY OF ANOVA OBTAINED FOR GE ON CURVILINEAR TASK IN EXPERIMENT 3.7

Source	SS	df	MS	F	p
Between subjects	2900.92	71			
Groups (G)	128.00	1	128.00	3.11	-
Preselection (P)	16.87	1	16.87	0.39	-
G x P	28.89	1	28.89	0.67	-
Subjects within group	2737.16	68	40.25		
Within subjects	12958.54	876			
Targets (T)	4011.32	2	2005.66	127.44	.01
G x T	167.36	2	83.68	4.90	.01
P x T	151.20	2	75.60	4.43	.05
G x P x T	10.21	2	5.10	0.30	-
T x subjects within group	2322.64	136	17.08		
Distractors (D)	33.28	2	16.64	1.14	-
G x D	151.41	2	75.71	5.11	.01
P x D	30.29	2	15.14	1.02	-
G x P x D	195.25	2	97.97	6.62	.01
D x subjects within groups	2013.15	136	14.80		
T x D	295.52	4	73.38	7.41	.01
G x T x D	117.22	4	29.31	2.96	.05
P x T x D	36.12	4	9.78	0.99	-
G x P x T x D	35.02	4	8.76	0.88	-
TD x subjects within groups	2604.25	272	9.91		
Total	15167.46	647			

3.245 and 4.74°, 5.98° and 7.34°; and mean VE scores are 3.70°, 5.42° and 5.80°; mean CE scores are 2.63°, -1.13° and 3.40°, respectively. Pattern of this recall error data supports the previously reported results.

Distractors were also found to affect recall in AE, F (2,136) = 72.86, $p < .01$, and VE, F (2,136) = 25.19, $p < .01$, analysis. For unfilled, verbal and movement distractor conditions mean AE scores are 4.60°, 6.80° and 6.65, and mean VE scores are 4.09, 5.33 and 5.50°, respectively. These results suggest that both verbal and movement distractors effectively hampered the reproduction performance.

A first order groups x targets interaction effect is significant only for CE analysis, F (2,136) = 4.90, $p < .01$. This interaction effect is shown with the help of means plotted in Fig. 3.7.2. It is observed from the figure that short movements were more overestimated but long movements underestimated by blind subjects than their sighted counterparts.

A group x distractors interaction effect was also significant in CE analysis: F (2,136) = 5.11, $p < .01$. Mean scores for this interaction effect are shown in Fig. 3.7.3. Verbal distractor caused positive biasing in the blind subjects. Movement interpolation turned the responses into negative direction for both blind and sighted subjects.

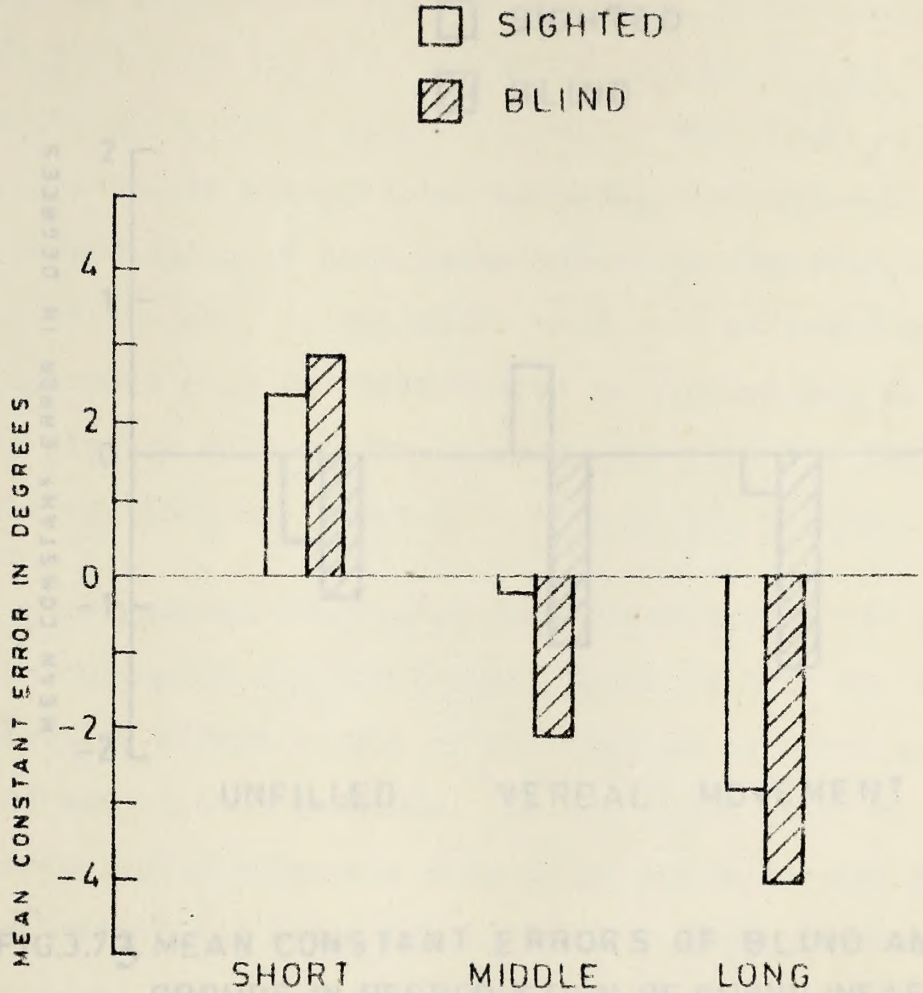


FIG.3.7.9 SHOWS MEAN CONSTRANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF SHORT, MIDDLE AND LONG TARGETS OF A CURVILINEAR TASK

SIGHTED
BLIND
4
2
0
-2
-4
MEAN CONSTANT ERROR IN DEGREES
SHORT
MIDDLE
LONG

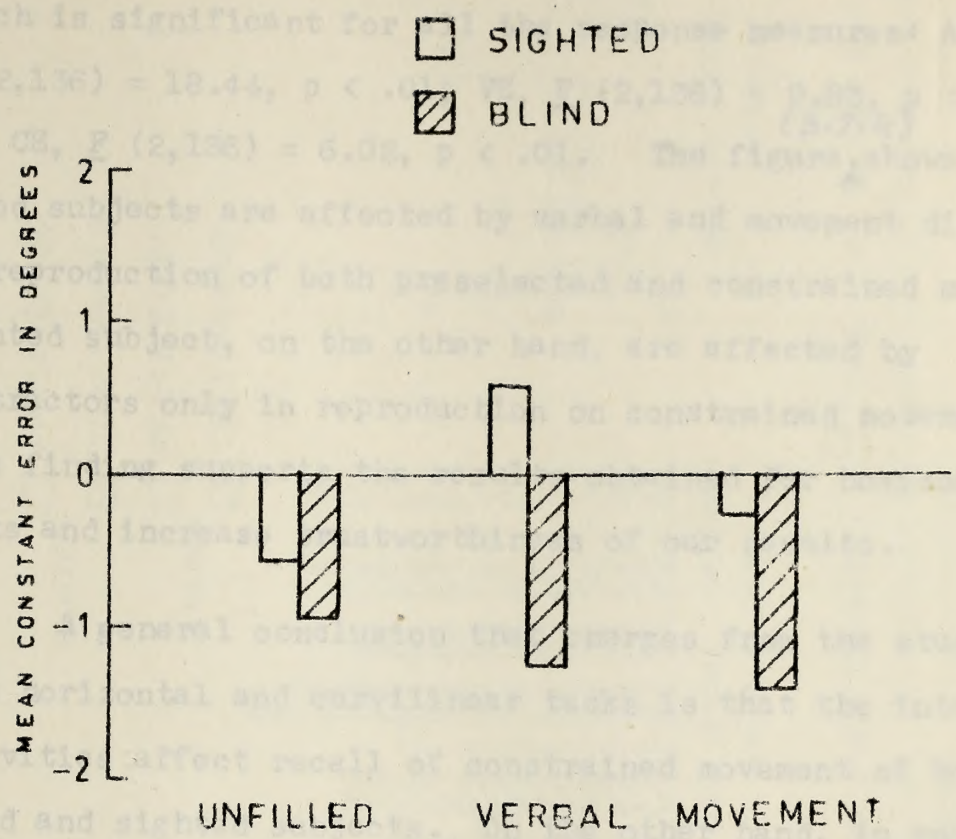
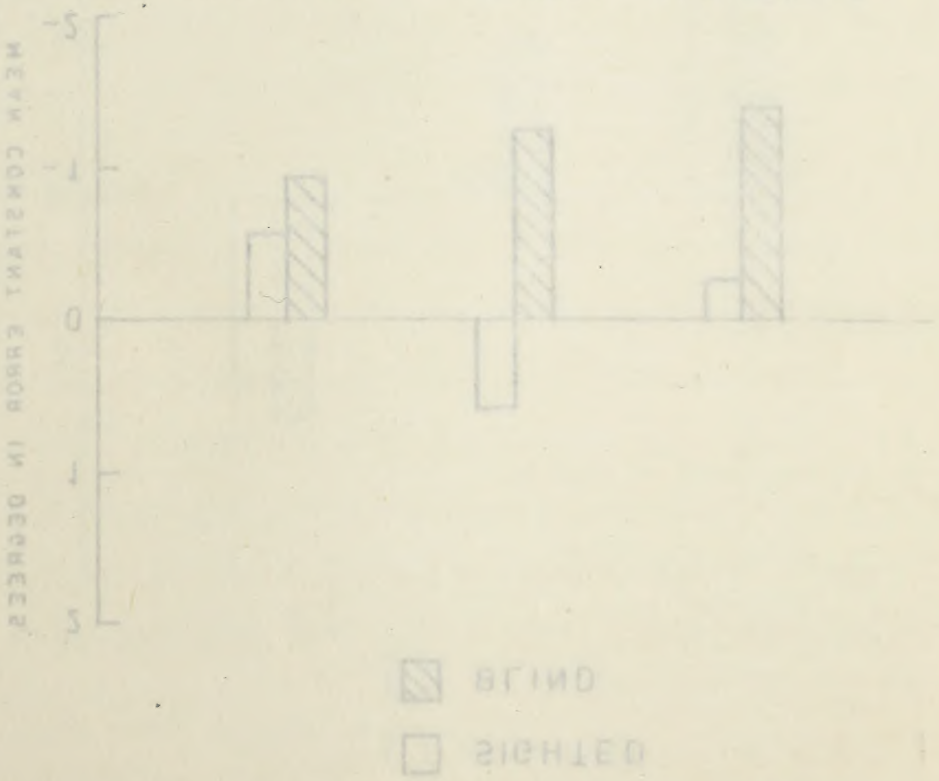


FIG.3.7.3 MEAN CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF CURVILINEAR MOVEMENT AS A FUNCTION OF DISTRACTORS


-5
-1
0
1
5
BLIND
SIGHTED

3.246 The most interesting third order interaction effect is a groups x preselection x distractors interaction effect which is significant for all the response measures: AE, $\underline{F}$ (2,136) = 18.44, $p < .01$; VE, $\underline{F}$ (2,136) = 9.83, $p < .01$; and CE, $\underline{F}$ (2,136) = 6.02, $p < .01$. The figure (3.7.4) shows that blind subjects are affected by verbal and movement distractors in reproduction of both preselected and constrained movements. Sighted subject, on the other hand, are affected by distractors only in reproduction on constrained movements. This finding supports the results obtained for horizontal tasks and increase trustworthiness of our results.

A general conclusion that emerges from the study of both horizontal and curvilinear tasks is that the interpolated activities affect recall of constrained movement of both blind and sighted subjects. On the other hand, in reproduction of preselected movements only blind subjects were affected by these verbal and motor activities. A group x preselection effect was significant for the horizontal task and makes it very obvious that groups differ mainly in reproduction of preselected movements but not in reproduction of constrained movements. This effect is not statistically significant in the reproduction of curvilinear movement which differs from that of the horizontal task in spatiotemporal nature of the task.

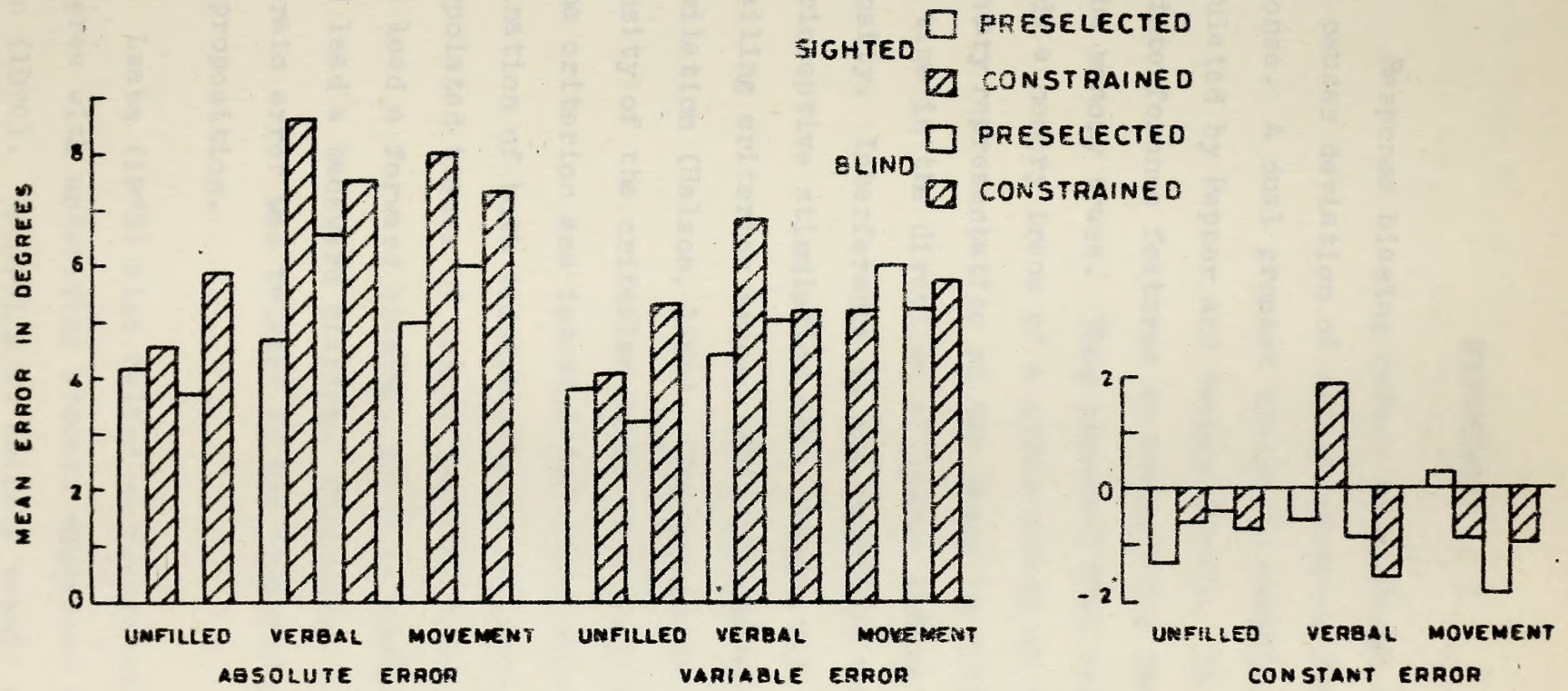


FIG. 3·7·4 MEANS ABSOLUTE, VARIABLE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUP IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS UNDER DIFFERENT DISTRACTOR CONDITIONS

UNGUIDED
GUIDED
BLIND
CONSTRAINED
PRESELECTED
SIGHTED
UNGUIDED
GUIDED
MEAN ERROR IN DEGREES

3.247

EXPERIMENT 3.8

Response biasing refers to a change in the memory trace that causes deviation of recall response from the criterion response. A dual process theory to explain this change was formulated by Pepper and Herman (1970). It involved decay and interference features to account for the abovesaid change of the memory trace. They proposed that criterion response yields a memory trace of a given extent or intensity. This momentary representation of the trace is subject to change over time in the direction of lesser extent or lesser intensity. Interference is the result of interpolated proprioceptive stimulation that changes the strength of the prevailing criterion trace. This phenomenon was called as assimilation (Helson, 1964). The change in the extent or intensity of the criterion trace is a result of interaction of the criterion and interpolated trace that yields a mean combination of both (assimilation). In other words, interpolated traces of longer magnitude than the criterion would lead a forward biasing, while of smaller magnitude would lead a backward biasing. Obviously, constant or algebraic error was treated as the index of memory in this proposition.

Laabs (1973) also relied on assimilation but he did not agree with underlying process suggested by Pepper and Herman (1970). According to Laabs, a recall response is made

3.248 in reference to an 'average' or 'central' movement and to the memory trace of the criterion movement. This 'central' or 'average' movement is also referred as referent. The referent movement is a combination of movements to be reproduced and is similar in concept to the adaptation level (AL) over the set of movements to be reproduced (Helson, 1964). He proposed that forgetting occurs due to decay within the kinesthetic mode of storage or to interference within the central mode of storage. Change in adaptation level, either through decay or interference, is expected to produce shift in CE. Criterion location, stored centrally and ending in sectors to the far right,are expected to show increased undershooting, and criterion locations ending in sectors to the far left are expected to show increased overshooting. In case of distance, which are stored kinesthetically as assumed by Laabs (1973), longer distance are expected to show increase in undershooting and shorter distances increase in overshooting. He also proposed that prediction can be made regarding CE when location is being used as a reproduction cue, and regarding VE when either location or distance is being used as reproduction cue. As kinesthetic memory trace (distance) decays or as the central memory trace (location) becomes subject to interference, a subject is able to make less perfect reproductions and his inconsistency is reflected in his variable error (VE). Constant error (CE) reflects the assimilation effect present at recall.

3.249 Having these two models in the background several empirical researches were conducted to examine the phenomena. Stelmach and Walsh (1972) reported that directional shift in error increase with the time spent at the interpolated locations. It was indicated in the CE analysis that interpolated longer movement shifted the error in positive direction, and interpolated movement of smaller magnitude shifted the error in negative direction. In their experiment it was also found that forward biasing caused more AE than backward biasing. Support for the above said findings was also gained in a subsequent work by them (Stelmach and Walsh 1973). In view of the abovesaid it is proposed that:

> Interpolated movement of longer magnitude than the criterion would shift the error in positive direction, while of shorter magnitude than the criterion would shift the recall error in negative direction.

As mentioned above, Laabs (1973) has a different notion, of assimilation than that proposed by Pepper and Herman (1970). It seems reasonable to propose on the basis of Laabs' notion of assimilation that :

> The position of a criterion target in the right or the left sector (i.e. long or short target, respectively) would influence the biasing effect.

3.250 Coming more specifically to the main theme of absence of vision, it is recalled that blind subjects respond at the time of recall mainly with reference to the proprioceptive information and, presumably, with reference to the physical position of the body. On the other hands, sighted subjects have the reference of body, as well as the visual reference of space. As argued earlier they rely on visual reference for their movements even in absence of direct visual feedback. Keeping this in view, it is proposed that:

> Recall response of sighted subjects would be less dependent on the referent movement or central movement than their blind counterparts.

Method and Procedure

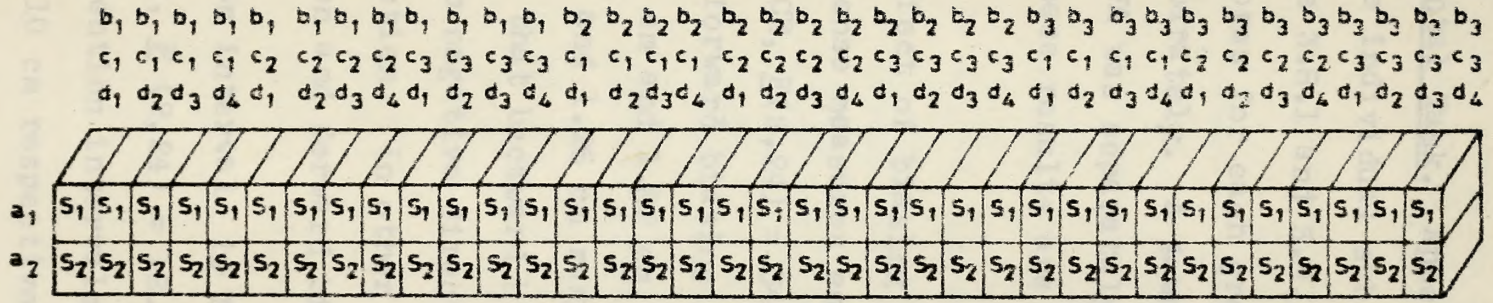
Sample. Fourteen congenitally blind and 14 sighted subjects were divided randomly into two groups of 7 each and they were randomly assigned to horizontal and curvilinear tasks. They were matched with respect to age, education and intelligence and all of them were righthanded males. The subjects of this experiment were taken from Varanasi city in Uttar Pradesh.

Apparatus. The apparatuses used in this experiment were a linear slide and a Manual Lever-D which were described earlier, a stop watch and a opaque goggle.

3.251 Experimental Design and Procedure . A 2 x 3 x 3 x 4 within subjects factorial design, involving groups (sighted or blind), biasing conditions (control, backward or forward) retention intervals (0 sec, 5 sec or 20 sec) and targets (10 cm/40°, 20 cm/50°, 30 cm/130° or 40 cm/140°) as independent variables, was employed for both horizontal and curvilinear tasks (Fig.3.8.1). In all, 36 trials were distributed equally in 3 sessions of 12 trials each with an intertrial interval of 1 minute.

The procedure of this experiment was identical to one emloyed by Stelmach and Walsh (1972). The subject was asked in the control condition to reproduce the criterion target from the starting point on which he rested for the period of retention interval. The forward or backward interpolated condition subject moved to a target position, stayed for 2 sec, and moved forward or backward by 5 cm/25°. At the end of the retention interval subjects reported the target points and subsequently the interpolated rest location. All the trials were presented randomly.

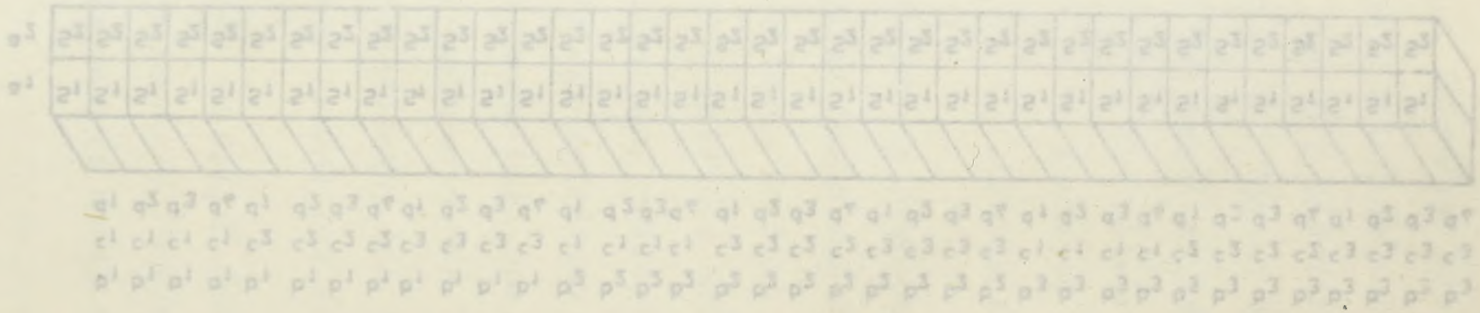
Dependent Variable. Only AE and CE was analysed in this experiment because only one trial of an experimental treatment was given to the subject.



a - GROUPS b - BIASING CONDITIONS c - RETENTION INTERVALS d - TARGETS

1) SIGHTED	1) CONTROL	1) 0 Sec.	1) 10 cm / 40°
2) BLIND	2) BACKWARD	2) 5 Sec.	2) 20 cm / 50°
	3) FORWARD	3) 20 Sec.	3) 30 cm / 130°
			4) 40 cm / 140°

FIG. 3·8·1. DESIGN OF EXPERIMENT 3·8



3.252 Results and Discussion

Horizontal Task. Appendix 3.XXXVI report the raw scores of the individual subjects separately on horizontal task. Tables 3.8.1 and 3.8.2 present means and S.D. of AE and CE scores for each group under every experimental condition separately. A 4-way 2 x 3 x 3 x 4 within subjects ANOVA was separately computed for AE and CE and a summary of these results are reported in Tables 3.8.3 and 3.8.4.

Main effect of biasing conditions is significant for both the response measures employed: AE, F (2,24) = 4.19, $p < .05$; and CE, $F(2,24) = 34.10$, $p < .01$. For control, backward and forward biasing conditions mean AE scores are 1.45 cm, 1.71 cm and 1.82 cm, and mean CE scores are 0.10 cm, - 0.58 cm and 1.26 cm respectively. It is clear from these results that backward biasing leads the recall responses into negative direction and forward biasing in positive direction. In other words, backward biasing causes underestimation and forward biasing causes overestimation.

Retention interval is found a significant factor only in AE analysis, F (2,24) = 18.19, $p < .01$. For 0 sec, 5 sec and 20 sec retention intervals, mean AE scores are 1.42 cm, 1.46 cm and 2.10 cm respectively. The results suggest that absolute error increases with increase in the delay in recall.

3.253

TABLE 3.8.1

MEAN AND SD (GIVEN IN BRACKETS) OF AE (IN CM.) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF HORIZONTAL MOVEMENTS

Retention Intervals	Targets (cm)	SIGHTED			BLIND		
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	10	0.46 (0.34)	0.77 (0.86)	1.87 (0.57)	1.27 (1.18)	1.76 (0.70)	1.74 (0.80)
	20	0.57 (0.47)	1.39 (0.94)	1.70 (1.13)	1.11 (1.01)	1.46 (1.33)	2.39 (0.58)
	30	1.13 (0.82)	0.83 (0.85)	1.33 (0.73)	0.84 (0.80)	2.07 (0.50)	1.69 (0.79)
	40	2.41 (1.61)	1.20 (1.23)	1.26 (0.54)	1.96 (1.39)	1.46 (1.12)	1.43 (1.28)
5 sec	10	0.81 (0.42)	0.71 (0.70)	1.57 (1.02)	1.17 (0.78)	1.14 (1.02)	1.86 (0.85)
	20	1.04 (0.80)	1.63 (0.86)	1.61 (0.83)	1.43 (0.45)	1.69 (0.87)	2.17 (1.06)
	30	1.27 (0.85)	1.40 (1.04)	0.94 (0.66)	1.71 (0.91)	1.31 (0.92)	1.16 (1.19)
	40	1.41 (1.30)	2.06 (0.75)	1.01 (0.67)	1.53 (1.07)	2.23 (1.80)	2.19 (1.56)
20 sec	10	1.27 (0.83)	0.97 (0.56)	2.33 (0.93)	1.60 (0.68)	1.66 (0.99)	1.73 (0.73)
	20	1.54 (1.28)	1.97 (1.26)	2.84 (1.22)	1.59 (1.37)	2.79 (0.87)	1.96 (1.07)
	30	1.69 (1.37)	2.27 (0.74)	2.29 (1.36)	1.97 (1.02)	1.86 (1.12)	1.47 (1.03)
	40	3.36 (2.27)	3.16 (0.86)	3.11 (2.32)	1.57 (1.01)	3.20 (1.53)	2.14 (1.48)

TABLE 3.8.1

MEAN AND SD (GIVEN IN BRACKETS) OF AS (IN CM.)
OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION
OF HORIZONTAL MOVEMENTS

Retention Interval	Targets (cm)	SIGHTED			BLIND		
		CNTL	RCWD	PWD	CNTL	SCWD	PSWD
0 sec	10	0.46 (0.34)	0.77 (0.86)	1.87 (0.87)	1.27 (1.18)	1.75 (0.70)	1.74 (0.80)
	20	0.87 (0.47)	1.39 (0.94)	1.70 (1.13)	1.11 (1.01)	1.46 (1.33)	2.87 (0.88)
	30	1.13 (0.82)	0.83 (0.85)	1.83 (0.73)	0.84 (0.80)	2.07 (0.80)	1.98 (0.79)
	40	2.41 (1.61)	1.20 (1.25)	1.86 (0.84)	1.96 (1.39)	1.46 (1.19)	1.82 (1.86)
5 sec	10	0.81 (0.42)	0.71 (0.70)	1.87 (1.02)	1.17 (0.76)	1.14 (1.06)	1.86 (0.88)
	20	1.04 (0.80)	1.65 (0.86)	1.61 (0.83)	1.43 (0.45)	1.89 (0.87)	2.12 (1.06)
	30	1.27 (0.85)	1.40 (1.04)	0.94 (0.66)	1.71 (0.91)	1.91 (0.92)	1.78 (1.19)
	40	1.41 (1.30)	2.06 (0.95)	1.01 (0.67)	1.53 (1.07)	2.22 (1.80)	2.19 (1.78)
20 sec	10	1.27 (0.83)	0.97 (0.85)	2.33 (0.85)	1.60 (0.68)	1.66 (0.90)	1.75 (0.78)
	20	1.64 (1.28)	1.97 (1.86)	2.84 (1.22)	1.80 (1.37)	2.76 (0.87)	1.96 (1.09)
	30	1.69 (1.37)	2.27 (0.74)	2.89 (1.36)	1.67 (1.02)	1.86 (1.16)	1.47 (1.08)
	40	3.36 (2.27)	3.16 (0.84)	3.11 (2.32)	1.87 (1.01)	3.20 (1.65)	2.14 (1.48)

3.254

TABLE 3.8.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE (IN CM) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF HORIZONTAL MOVEMENTS

Retention Intervals	Targets (cm)	SIGHTED			BLIND		
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	10	0.46 (0.36)	0.60 (1.01)	1.87 (0.57)	1.21 (1.25)	0.67 (1.89)	1.74 (0.80)
	20	-0.03 (0.72)	-0.93 (1.46)	1.70 (1.13)	0.63 (1.42)	0.26 (2.04)	2.39 (0.58)
	30	-0.41 (1.40)	-0.83 (0.85)	1.33 (0.73)	-0.79 (0.86)	-0.36 (2.26)	1.69 (0.79)
	40	-1.84 (2.33)	-1.20 (1.23)	0.94 (1.05)	-1.96 (1.39)	-1.37 (1.24)	-0.66 (1.87)
5 sec	10	0.81 (0.42)	0.49 (0.90)	1.34 (1.35)	1.17 (0.78)	1.06 (1.12)	1.86 (0.85)
	20	-0.16 (1.37)	-1.63 (0.86)	1.50 (1.05)	1.20 (0.95)	1.54 (1.14)	2.17 (1.06)
	30	-0.04 (1.62)	-0.89 (1.56)	0.94 (0.66)	-0.31 (2.04)	-0.57 (1.57)	1.07 (1.28)
	40	-0.64 (1.88)	-2.06 (0.75)	0.64 (1.08)	-0.01 (1.97)	-2.06 (2.02)	-1.01 (2.61)
20 sec	10	1.27 (0.83)	0.37 (1.12)	2.33 (0.93)	1.60 (0.68)	1.54 (1.18)	1.73 (0.73)
	20	1.26 (1.61)	-1.54 (1.83)	2.41 (2.03)	1.27 (1.71)	1.24 (2.83)	1.96 (1.07)
	30	0.40 (2.24)	-1.81 (1.65)	0.74 (2.70)	-1.03 (2.08)	-0.77 (2.14)	0.13 (1.89)
	40	0.01 (4.28)	-3.16 (0.86)	3.11 (2.32)	-1.37 (1.30)	-2.40 (2.75)	-1.80 (1.94)

TABLE 3.8.2

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE (IN CM) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF HORIZONTAL MOVEMENTS

Retention Interval	Targets (cm)	SIGHTED				BLIND	
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	10	0.46 (0.36)	0.60 (1.01)	1.87 (0.87)	1.81 (1.35)	0.87 (1.29)	1.74 (0.80)
	20	-0.03 (0.72)	-0.93 (1.48)	1.70 (1.13)	0.83 (1.42)	0.36 (2.04)	2.39 (0.88)
	30	-0.41 (1.40)	-0.83 (0.85)	1.53 (0.73)	-0.79 (0.86)	-0.36 (2.86)	1.69 (0.79)
	40	-1.84 (2.33)	-1.20 (1.23)	0.94 (1.05)	-1.96 (1.39)	-1.37 (1.84)	-0.66 (1.87)
5 sec	10	0.81 (0.42)	0.49 (0.80)	1.34 (1.35)	1.17 (0.78)	1.06 (1.12)	1.86 (0.88)
	20	-0.16 (1.37)	-1.63 (0.86)	1.50 (1.05)	1.20 (0.85)	1.64 (1.14)	2.17 (1.08)
	30	-0.04 (1.82)	-0.89 (1.36)	0.94 (0.66)	-0.31 (2.04)	-0.87 (1.37)	1.07 (1.30)
	40	-0.64 (1.88)	-2.06 (0.75)	0.84 (1.08)	-0.01 (1.87)	-2.06 (2.02)	-1.01 (2.61)
20 sec	10	1.27 (0.83)	0.37 (1.12)	2.33 (0.93)	1.60 (0.88)	1.64 (1.18)	1.73 (0.73)
	20	1.26 (1.61)	-1.54 (1.83)	2.41 (2.05)	1.87 (1.71)	1.64 (2.83)	1.82 (1.07)
	30	0.40 (2.24)	-1.81 (1.65)	0.74 (2.70)	-1.03 (2.08)	-0.77 (2.14)	0.13 (1.89)
	40	0.01 (4.28)	-3.16 (0.86)	3.11 (2.32)	-1.87 (1.30)	-3.40 (2.75)	-1.10 (1.96)

3.255

TABLE 3.8.3

SUMMARY OF ANOVA OBTAINED FOR AE OF HORIZONTAL TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	48.42	13			
Groups (G)	2.51	1	2.51	0.66	-
Subjects within groups	45.90	12	3.83		
Within subjects	634.66	490	1.30		
Biasing conditions (B)	12.53	2	6.27	4.19	.05
Retention Intervals (R)	48.38	2	24.19	18.19	.01
Targets (T)	31.56	3	10.52	5.99	.01
G x B	2.95	2	1.48	0.99	-
G x R	10.80	2	5.40	4.06	.05
G x T	4.36	3	1.45	0.83	-
B x R	2.10	4	0.53	0.39	-
B x T	23.09	6	3.85	4.22	.01
R x T	9.00	6	1.50	1.90	-
G x B x R	8.52	4	2.13	1.57	-
G x B x T	7.11	6	1.19	1.30	-
G x R x T	4.78	6	0.80	1.01	-
B x R x T	15.89	12	1.32	1.52	-
G x B x R x T	9.50	12	0.79	0.92	-
B x subjects within groups	35.93	24	1.50		
R x subjects within groups	31.92	24	1.33		
T x subjects within groups	63.23	36	1.76		
BR x subjects within groups	65.06	48	1.36		
BT x subjects within groups	65.62	72	0.91		
RT x subjects within groups	56.75	72	0.79		
BRT x subjects within groups	125.57	144	0.87		
Total	683.07	503	1.36		

TABLE 3.8.3

SUMMARY OF ANOVA OBTAINED FOR AS OF HORIZONTAL TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	48.42	13			
Groups (G)	2.31	1	2.31	0.66	-
Subjects within groups	45.80	12	3.83		
Within subjects	634.66	190	1.30		
Blasting conditions (B)	12.83	2	6.27	4.10	.05
Retention Intervals (R)	48.38	2	24.19	18.19	.01
Targets (T)	31.56	3	10.52	8.09	.01
G x B	3.65	2	1.48	0.89	-
G x R	10.80	2	5.40	4.06	.05
G x T	4.30	3	1.43	0.83	-
B x R	2.10	4	0.52	0.39	-
B x T	23.09	6	3.85	4.22	.01
R x T	9.00	6	1.50	1.90	-
G x B x R	8.52	4	2.13	1.57	-
G x B x T	7.11	6	1.19	1.30	-
G x R x T	4.76	6	0.80	1.01	-
B x R x T	15.89	12	1.32	1.52	-
G x B x R x T	9.50	12	0.79	0.92	-
B x subjects within groups	35.95	24	1.50		
R x subjects within groups	31.92	24	1.33		
T x subjects within groups	63.25	36	1.76		
BR x subjects within groups	65.06	48	1.36		
BT x subjects within groups	65.62	72	0.91		
RT x subjects within groups	56.75	72	0.79		
BRT x subjects within groups	152.87	144	0.27		
Total	883.07	503	1.36		

3.256

TABLE 3.8.4

SUMMARY OF ANOVA OBTAINED FOR CE OF HORIZONTAL TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	145.64	13			
Groups (G)	1.96	1	1.96	0.16	-
Subjects within groups	143.69	12	11.96		
Within subjects	1890.99	490	3.86		
Biasing conditions (B)	287.66	2	143.83	34.10	.01
Retention Intervals (R)	0.98	2	0.49	0.26	-
Targets (T)	354.99	3	118.33	44.10	.01
G x B	52.82	2	26.41	6.26	.01
G x R	12.15	2	6.08	3.25	-
G x T	70.54	3	23.51	8.76	.01
B x R	26.86	4	6.72	4.27	.01
B x T	22.06	6	3.68	1.56	-
R x T	14.12	6	2.35	1.16	-
G x B x R	27.27	4	6.82	4.34	.01
G x B x T	35.38	6	5.90	2.50	-
G x R x T	8.61	6	1.43	0.71	-
B x R x T	25.50	12	2.13	0.99	-
G x B x R x T	10.56	12	0.88	0.41	-
B x subjects within groups	101.23	24	4.22		
R x subjects within groups	44.88	24	1.87		
T x subjects within groups	96.6	36	2.68		
BR x subjects within groups	75.44	48	1.57		
BT x subjects within groups	169.5	72	2.35		
RT x subjects within groups	145.52	72	2.02		
BRT x subjects within groups	308.31	144	2.14		
Total	2036.63	503	4.05		

TABLE 3.8.4

SUMMARY OF ANOVA OBTAINED FOR CE OF HORIZONTAL TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	146.64	13			
Groups (G)	1.36	1	1.36	0.16	-
Subjects within groups	145.69	12	11.96		
Within subjects	1890.90	490	3.86		
Blasing conditions (B)	287.66	2	143.83	34.10	.01
Retention Intervals (R)	0.98	2	0.49	0.36	-
Targets (T)	554.59	3	118.33	44.10	.01
G x B	62.82	2	30.41	6.86	.01
G x R	12.15	2	6.08	3.25	-
G x T	70.54	3	23.51	8.76	.01
B x R	26.86	4	6.72	4.27	.01
B x T	22.06	6	3.68	1.36	-
R x T	14.12	6	2.35	1.16	-
G x B x R	27.27	4	6.82	4.34	.01
G x B x T	35.38	6	5.90	2.20	-
G x R x T	8.61	6	1.43	0.71	-
B x R x T	25.50	12	2.13	0.69	-
G x B x R x T	10.85	12	0.88	0.41	-
B x subjects within groups	101.23	24	4.22		
R x subjects within groups	44.88	24	1.87		
T x subjects within groups	86.6	36	2.68		
BR x subjects within groups	78.44	48	1.87		
BT x subjects within groups	189.5	72	2.45		
RT x subjects within groups	145.82	72	2.02		
BRT x subjects within groups	308.31	144	2.14		
Total	2956.85	805	4.06		

2.257 Main effect of targets is significant in both the error analyses employed: AE, F (3,36) = 5.99, $p < .01$; and CE, F (3,36) = 44.01, $p < .01$. For target sectors 1, 2, 3 and 4 (short to long) mean AE scores are 1.37 cm, 1.72 cm, 1.51 cm and 2.04 cm; and mean CE scores are 1.23 cm, 0.84 cm, -0.08 cm and -0.93 cm, respectively. Results indicate that AE not only depended on the length of movement but also on the specific location of the targets. CE changes from positive to negative with increase in the length of the target.

A groups x biasing activity interaction is significant for CE, F (2,24) = 6.27, $p < .01$. Mean scores for this interaction effect are shown in Fig.3.8.2. It suggests that backward biasing causes significantly more underestimation in the sighted than the blind subjects. On the other hand, forward biasing causes more overestimation in the sighted than the blind subjects.

A groups x retention interval interaction effect is significant only in CE analysis, F (2,24) = 4.06, $p < .05$. This interaction effect suggests that retention intervals do not affect the response pattern of the blind and sighted subjects similarly.

An interesting observation about recall of various targets length by blind and sighted subjects is available in a groups x targets interaction effect found significant

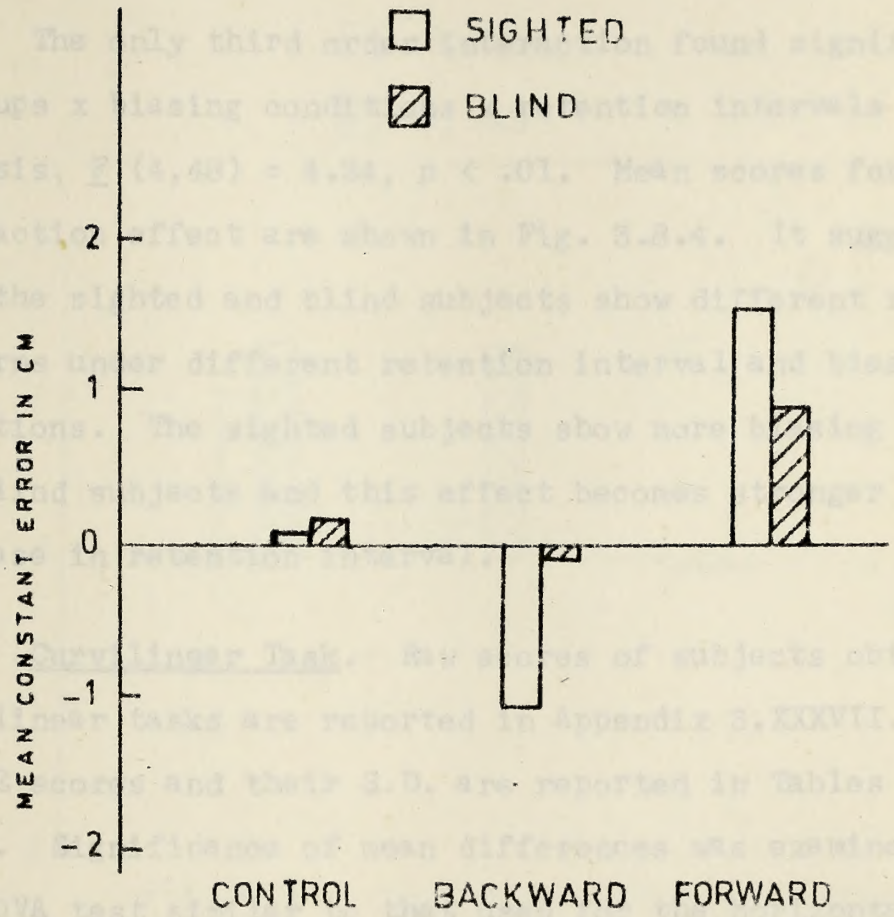
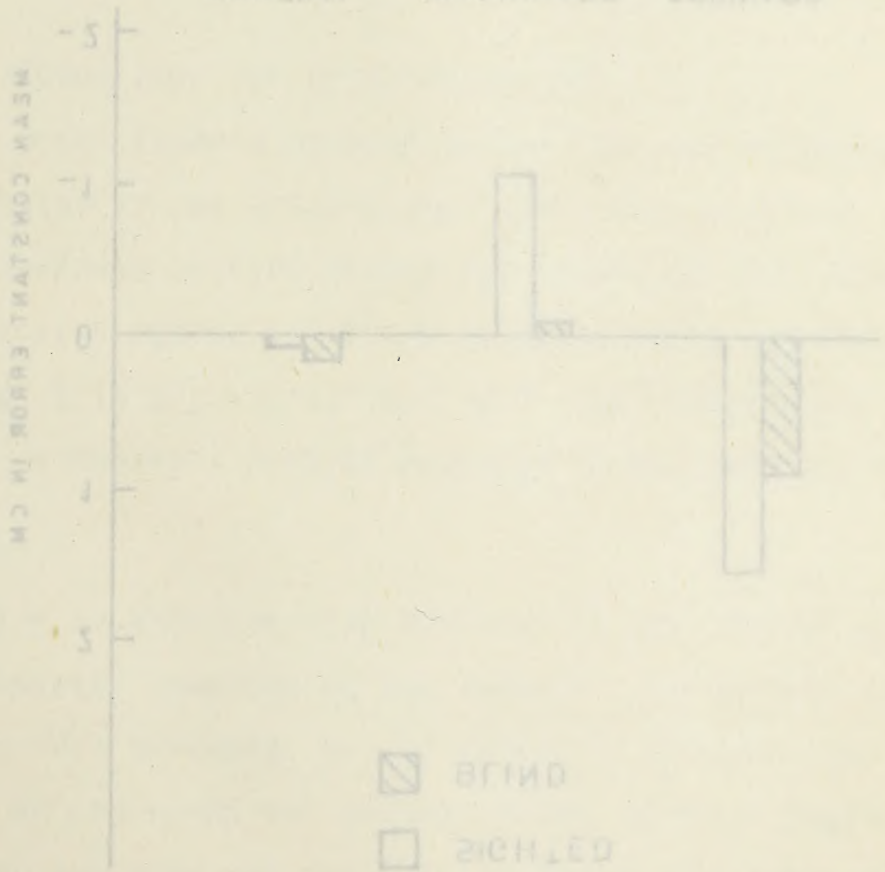


FIG.3.8.2 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS UNDER DIFFERENT BIASING CONDITIONS


-2
-1
0
1
2
BLIND
SIGHTED

3.258 in CE analysis, F (3,36) = 8.76, $p < .01$. This interaction effect (see Fig. 3.8.3) indicated that short targets are more overestimated and long targets more underestimated by blind subjects than their sighted counterpart.

The only third order interaction found significant is a groups x biasing conditions x retention intervals in CE analysis, F (4,48) = 4.34, $p < .01$. Mean scores for this interaction effect are shown in Fig. 3.8.4. It suggests that the sighted and blind subjects show different response patterns under different retention interval and biasing conditions. The sighted subjects show more biasing than the blind subjects and this effect becomes stronger with increase in retention interval.

Curvilinear Task. Raw scores of subjects obtained on curvilinear tasks are reported in Appendix 3.XXXVII. Mean AE and CE scores and their S.D. are reported in Tables 3.8.5 and 3.8.6. Significance of mean differences was examined using an ANOVA test similar to that used for the horizontal task and a summary of these tests for AE and CE is reported in Tables 3.8.7 and 3.8.8.

Main effect of groups is significant in AE analysis, F (1,12) = 8.03, $p < .01$. Mean AE scores for the sighted and blind groups are 5.11° and 6.40°, respectively.

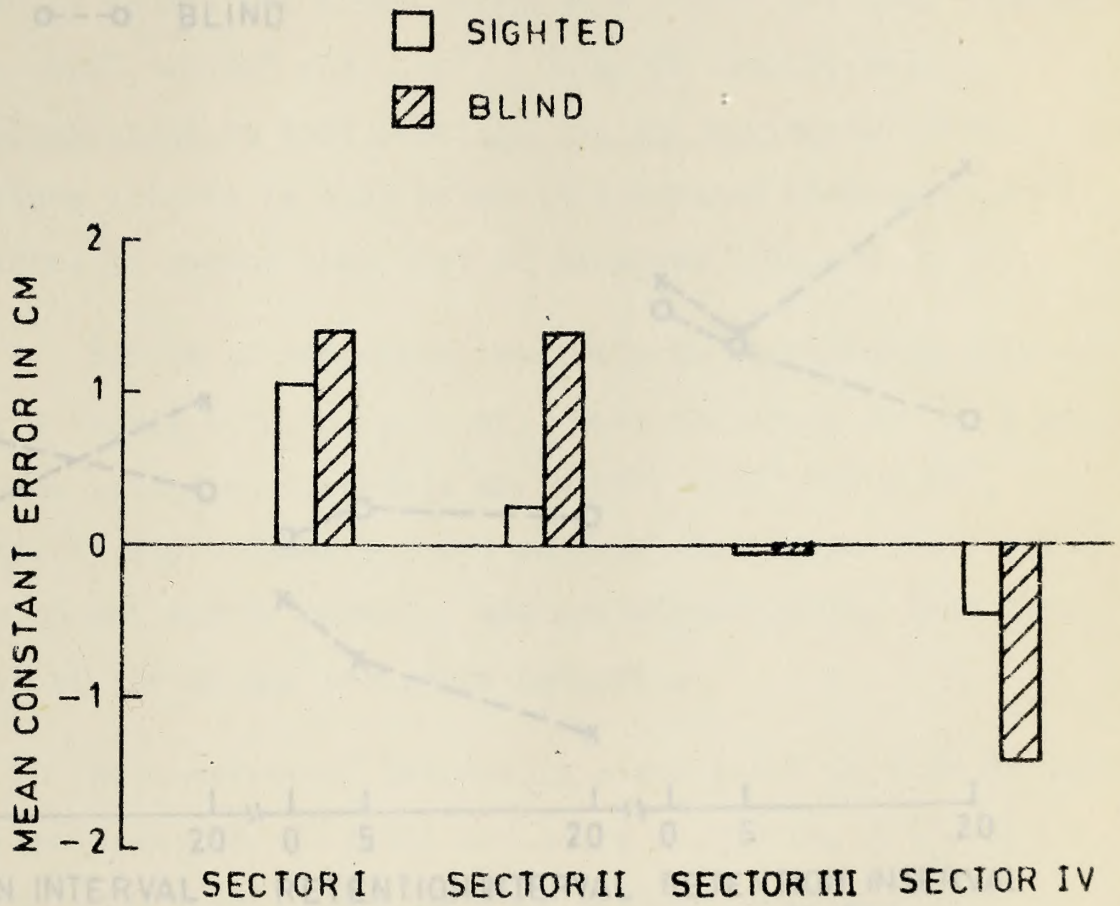
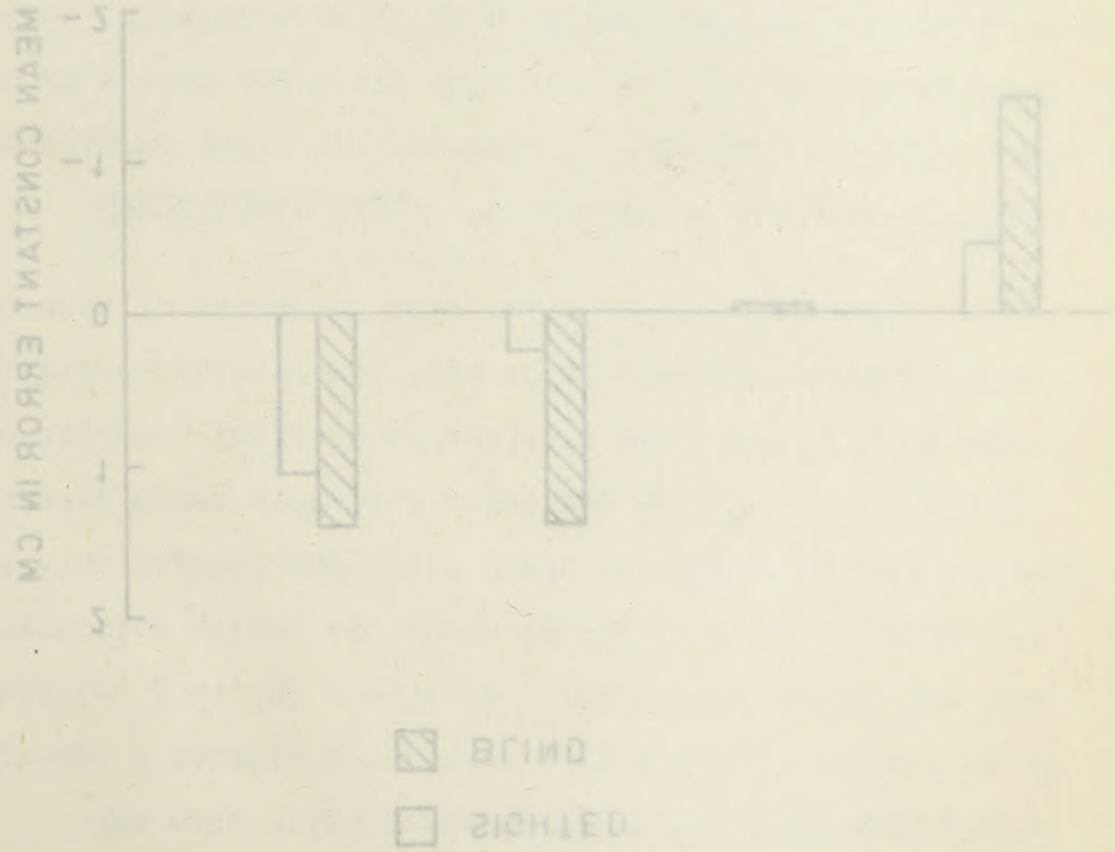


FIG.3.8.3 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF VARIOUS TARGETS


SECTOR I
SECTOR II
SECTOR III
SECTOR IV
MEAN CONSTANT ERROR IN CM
5
1
0
1
5
BLIND
SIGHTED

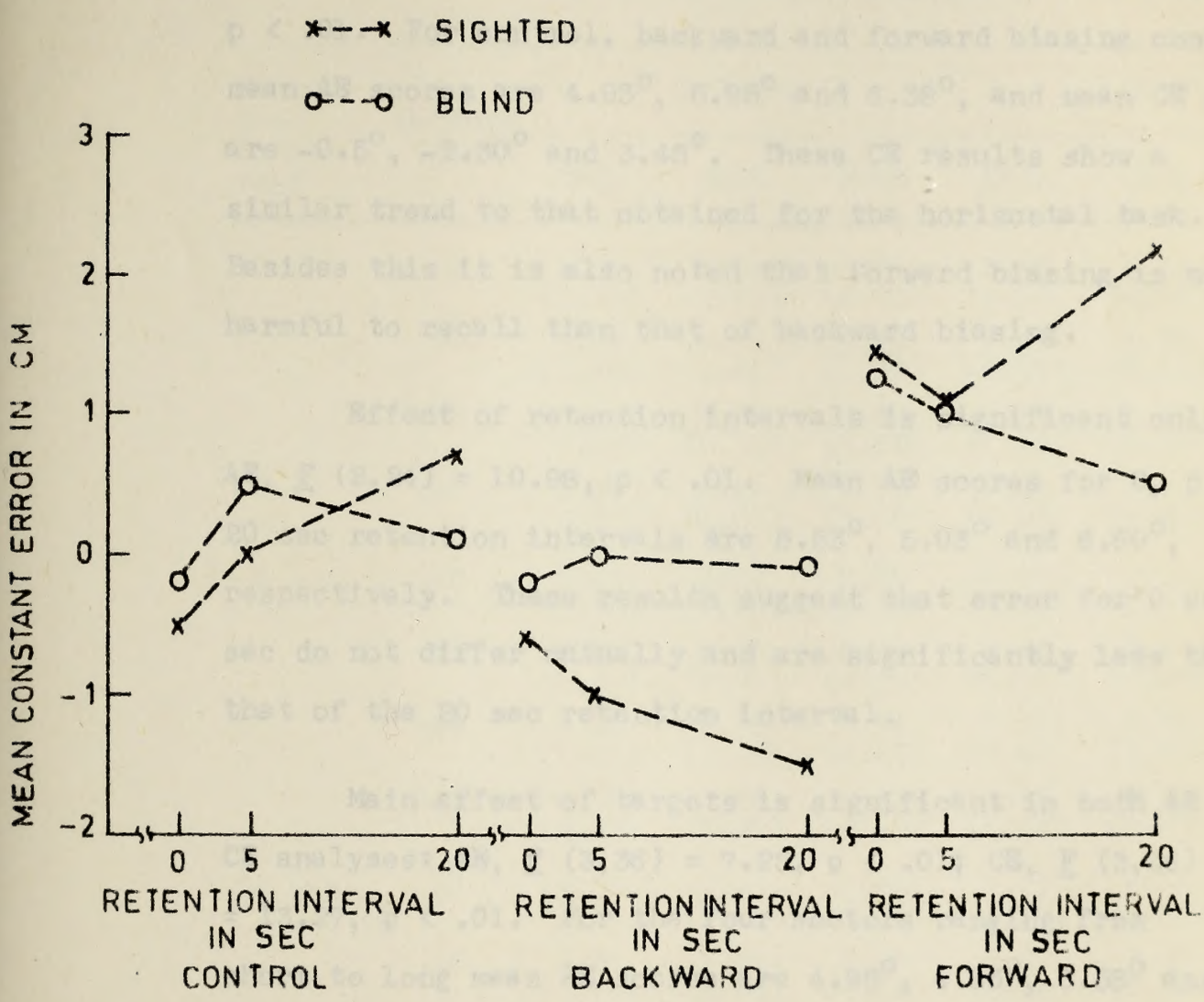


FIG.3.8.4 SHOWING CONSTANT ERRORS OF BLIND AND SIGHTED SUBJECTS IN REPRODUCTION OF MOVEMENT UNDER DIFFERENT RETENTION INTERVAL AND BIASING CONDITIONS

SIGHTED
BLIND
MEAN CONSTANT ERROR IN CM
3
2
1
0
-1
-2
0
5
20
0
5
20
RETENTION INTERVAL
IN SEC
CONTROL
BACKWARD
FORWARD

3.259 Biasing conditions are found to be a significant factor in analysis of both the response measures employed: AE, $\underline{F}$ (2,24) = 6.68, $p < .01$; and CE, $\underline{F}$ (2,24) = 25.59, $p < .01$. For control, backward and forward biasing conditions mean AE scores are 4.93°, 5.95° and 6.38°, and mean CE scores are -0.5°, -2.30° and 3.45°. These CE results show a similar trend to that obtained for the horizontal task. Besides this it is also noted that forward biasing is more harmful to recall than that of backward biasing.

Effect of retention intervals is significant only for AE, $\underline{F}$ (2,24) = 10.98, $p < .01$. Mean AE scores for 0, 5 and 20 sec retention intervals are 5.53°, 5.03° and 6.69°, respectively. These results suggest that error for 0 and 5 sec do not differ mutually and are significantly less than that of the 20 sec retention interval.

Main effect of targets is significant in both AE and CE analyses: AE, $\underline{F}$ (3,36) = 7.25, $p < .01$; CE, $\underline{F}$ (3,36) = 13.27, $p < .01$. For the four sectors ranging from short to long mean AE scores are 4.95°, 4.85°, 6.58° and 6.63°; and mean CE scores are 2.86°, 1.67°, -0.98° and -2.69°, respectively. These results are again similar to those observed in the previous experiments.

The only interesting first order interaction found significant is a group x targets interaction effect in CE

3.260

TABLE 3.8.5

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF CURVILINEAR MOVEMENTS

Retention Intervals	Targets (deg.)	SIGHTED			BLIND		
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	40	2.29 (3.15)	4.14 (2.73)	4.71 (4.03)	3.57 (3.10)	4.29 (2.06)	9.14 (4.10)
	50	3.29 (1.98)	3.71 (2.98)	6.29 (3.64)	2.57 (2.07)	3.29 (1.60)	7.71 (2.81)
	130	5.14 (5.87)	7.57 (2.51)	9.00 (7.62)	4.14 (1.46)	7.43 (2.70)	8.00 (3.21)
	140	4.57 (3.05)	6.14 (6.87)	5.00 (5.60)	6.00 (2.09)	9.71 (4.61)	5.00 (3.92)
5 sec	40	3.43 (1.90)	5.14 (1.95)	2.29 (1.89)	3.00 (2.83)	3.14 (1.77)	8.29 (3.04)
	50	3.00 (2.08)	4.00 (2.31)	3.29 (2.56)	4.43 (1.27)	5.29 (1.50)	8.29 (2.06)
	130	3.86 (2.48)	5.00 (3.37)	6.14 (4.95)	6.00 (2.45)	6.71 (2.75)	3.71 (1.89)
	140	6.29 (3.45)	5.86 (3.08)	5.29 (4.19)	6.00 (1.53)	5.71 (2.06)	6.71 (3.64)
20 sec	40	3.86 (2.34)	4.43 (2.99)	4.00 (2.38)	7.29 (6.13)	5.14 (3.63)	11.00 (3.61)
	50	3.57 (3.78)	3.57 (2.94)	4.29 (2.56)	4.57 (2.44)	7.00 (2.16)	9.14 (3.80)
	130	7.14 (7.27)	7.57 (4.16)	8.43 (4.39)	6.86 (5.27)	9.57 (2.51)	6.14 (2.27)
	140	8.43 (8.20)	8.00 (4.97)	5.14 (4.22)	9.00 (3.92)	10.29 (6.13)	6.14 (3.24)

TABLE 3.8.5

MEAN AND S.D. (GIVEN IN BRACKETS) OF AE (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF CURVILINEAR MOVEMENTS

Retention Interval	Targets (deg.)	SIGHTED				BLIND	
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	40	2.29 (3.15)	4.14 (2.73)	4.71 (4.03)	3.57 (3.10)	4.29 (2.06)	0.14 (4.10)
	80	3.29 (1.98)	3.71 (2.98)	6.29 (3.64)	2.57 (2.07)	3.29 (1.60)	7.71 (2.81)
	120	5.14 (5.87)	7.57 (2.81)	9.00 (7.62)	4.14 (1.46)	7.43 (2.70)	8.00 (3.21)
	140	4.57 (3.05)	6.14 (6.87)	5.00 (5.60)	6.00 (2.09)	9.71 (4.61)	8.00 (3.58)
5 sec	40	3.43 (1.90)	5.14 (1.95)	2.29 (1.89)	3.00 (2.85)	3.14 (1.77)	8.29 (3.04)
	80	3.00 (2.08)	4.00 (2.31)	3.29 (2.56)	4.43 (1.27)	5.29 (1.30)	8.29 (2.06)
	120	3.86 (2.48)	8.00 (3.37)	6.14 (4.95)	6.00 (2.45)	6.71 (2.75)	8.71 (1.89)
	140	6.29 (3.45)	5.86 (3.08)	5.29 (4.19)	6.00 (1.53)	5.71 (2.08)	6.71 (3.58)
20 sec	40	3.86 (2.34)	4.43 (2.59)	4.00 (2.59)	7.29 (6.13)	5.14 (3.83)	11.00 (4.30)
	80	3.57 (3.78)	3.57 (2.94)	4.29 (2.56)	4.57 (2.44)	7.00 (2.16)	9.14 (3.80)
	120	7.14 (7.27)	7.57 (4.16)	8.43 (4.39)	6.86 (6.27)	9.57 (2.81)	6.14 (3.27)
	140	8.43 (8.20)	8.00 (4.97)	5.14 (4.29)	9.00 (3.92)	10.29 (6.13)	6.14 (3.94)

3.261

TABLE 3.8.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE (IN DEGREES) OF BLIND AND SIGHTED GROUPS IN SIMPLE REPRODUCTION OF CURVILINEAR MOVEMENTS

Retention Intervals	Targets (deg.)	SIGHTED			BLIND		
		CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	40	1.14 (3.80)	-1.86 (4.85)	3.86 (4.98)	3.57 (3.10)	1.14 (4.91)	9.14 (4.10)
	50	-1.86 (3.53)	-3.14 (3.67)	6.00 (4.16)	1.71 (2.93)	0.71 (3.82)	7.71 (2.81)
	130	-2.86 (7.47)	-3.29 (7.78)	-6.71 (10.00)	-1.00 (4.58)	-2.29 (8.10)	8.00 (3.21)
	140	1.43 (5.59)	-4.14 (8.43)	3.57 (6.75)	-6.00 (2.08)	-6.57 (9.00)	-3.57 (5.44)
5 sec	40	-0.57 (4.12)	-0.57 (5.86)	0.57 (3.05)	3.00 (2.83)	-0.29 (3.82)	8.29 (3.04)
	50	-0.71 (3.77)	-1.43 (4.05)	3.00 (2.94)	1.86 (4.53)	1.86 (5.55)	8.29 (2.06)
	130	-0.14 (4.85)	1.57 (6.13)	3.00 (7.62)	-4.57 (4.86)	-1.00 (7.68)	1.71 (4.03)
	140	0.29 (7.61)	-3.86 (5.67)	0.71 (7.04)	-4.57 (4.47)	-5.14 (3.39)	1.57 (7.93)
20 sec	40	1.57 (4.47)	-2.43 (5.00)	4.00 (2.38)	7.29 (6.13)	2.57 (6.02)	11.00 (3.61)
	50	3.00 (4.32)	-3.00 (3.61)	-2.86 (4.30)	3.14 (4.34)	-3.29 (7.02)	9.14 (3.80)
	130	-1.43 (10.49)	-1.86 (8.95)	2.71 (9.67)	-6.00 (6.38)	-5.86 (8.55)	2.43 (6.50)
	140	-1.57 (12.14)	-5.14 (8.28)	3.71 (5.71)	-8.71 (4.61)	-8.00 (9.29)	-2.43 (6.90)

TABLE 3.3.6

MEAN AND S.D. (GIVEN IN BRACKETS) OF CE (IN DEGREES) OF HEIND AND SICHTED ORBITS IN SIMPLE REPRODUCTION OF CURVILINEAR MOVEMENTS

Retention Interveis	Targets (deg.)	SICHTED				HEIND	
		CNTL	BCWD	PRWD	CNTL	BCWD	PRWD
0 sec	40	1.14 (3.80)	-1.86 (4.84)	3.86 (4.84)	8.57 (3.10)	1.14 (4.81)	7.43 (4.10)
	80	-1.86 (3.83)	-3.14 (3.87)	6.00 (4.16)	1.71 (6.95)	0.71 (8.82)	7.71 (5.41)
	120	-6.86 (7.47)	-6.29 (7.78)	-6.71 (10.00)	-1.00 (4.88)	-2.29 (8.10)	8.00 (8.21)
	160	1.43 (5.39)	-4.14 (8.43)	5.57 (6.78)	-6.00 (2.06)	-6.87 (6.00)	-5.57 (6.44)
6 sec	40	-0.57 (4.12)	-0.57 (5.86)	0.57 (5.05)	8.00 (8.93)	-0.29 (3.82)	8.57 (3.04)
	80	-0.71 (3.77)	-1.43 (4.05)	3.00 (8.94)	1.00 (4.82)	1.86 (6.36)	8.86 (6.04)
	120	-0.14 (4.85)	1.57 (8.13)	3.00 (7.82)	-4.57 (4.86)	-1.00 (7.65)	1.43 (4.02)
	160	0.29 (7.61)	-3.86 (5.87)	0.71 (7.04)	-4.57 (4.47)	-6.14 (3.39)	1.57 (7.23)
20 sec	40	1.57 (4.47)	-5.43 (5.00)	4.00 (8.38)	7.29 (6.13)	7.57 (6.02)	11.00 (8.81)
	80	3.00 (4.32)	-3.00 (5.81)	-5.86 (4.30)	3.14 (4.13)	-4.00 (7.08)	9.14 (5.80)
	120	-1.43 (10.49)	-1.86 (8.08)	8.71 (9.87)	-6.00 (6.29)	-6.86 (5.86)	5.43 (6.20)
	160	-1.57 (12.14)	-6.14 (8.29)	8.71 (6.71)	-8.00 (4.01)	-8.00 (5.29)	-8.43 (6.80)

3.262

TABLE 3.8.7

SUMMARY OF ANOVA OBTAINED FOR AE OF CURVILINEAR TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	522.58	13			
Groups (G)	209.57	1	209.57	8.03	.01
Subjects within groups	313.01	12	26.08		
Within subjects	7509.42	490	15.33		
Biasing conditions (B)	186.72	2	93.36	6.68	.01
Retention Intervals (R)	242.46	2	121.23	10.98	.01
Targets (T)	365.97	2	121.99	7.25	.01
G x B	45.5	2	22.75	1.63	-
G x R	32.93	2	16.47	1.49	-
G x T	109.63	3	36.54	2.17	-
B x R	95.52	4	23.88	1.78	-
B x T	336.28	6	56.05	4.13	.01
R x T	59.40	6	9.90	0.65	-
G x B x R	16.83	4	4.21	0.31	-
G x B x T	288.32	6	48.05	3.54	.01
G x R x T	73.56	6	12.26	0.80	-
B x R x T	114.00	12	9.50	0.88	-
G x B x R x T	59.3	12	4.94	0.46	-
B x subjects within groups	335.28	24	13.97		
R x subjects within groups	264.94	24	11.04		
T x subjects within groups	605.60	36	16.32		
BR x subjects within groups	644.48	48	13.43		
BT x subjects within groups	976.79	72	13.57		
RT x subjects within groups	1101.59	72	15.30		
BRT x subjects within groups	1554.31	144	10.79		
Total	8032.00	503	15.97		

TABLE B.8.7

SUMMARY OF ANOVA OBTAINED FOR AS OF CURVILINEAR TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects					
Groups (G)					
Subjects within groups					
Within subjects					
Biasing conditions (B)					
Retention intervals (R)					
Targets (T)					
G x B					
G x R					
G x T					
B x R					
B x T					
R x T					
G x B x R					
G x B x T					
G x R x T					
B x R x T					
G x B x R x T					
B x subjects within groups					
R x subjects within groups					
T x subjects within groups					
BR x subjects within groups					
BT x subjects within groups					
RT x subjects within groups					
BRT x subjects within groups					
Total					

3.263

TABLE 3.8.8

SUMMARY OF ANOVA OBTAINED FOR CE OF CURVILINEAR TASK IN EXPERIMENT 3.8

Source	SS	df	MS	F	p
Between subjects	1068.90	13			
Groups (G)	113.34	1	113.34	1.42	-
Subjects within groups	955.56	12	79.63		
Within subjects	2361.53	490	48.19		
Biasing conditions (B)	2912.29	2	1456.14	25.59	.01
Retention Intervals (R)	32.29	2	16.14	0.72	-
Targets (T)	2390.48	3	796.83	13.27	.01
G x B	370.74	2	285.37	3.26	-
G x R	38.86	2	19.43	0.87	-
G x T	1485.04	3	495.01	8.25	.01
B x R	116.62	4	29.15	1.31	-
B x T	175.15	6	29.19	1.11	-
R x T	251.63	6	41.94	1.12	-
G x B x R	8.12	4	2.03	0.09	-
G x B x T	228.10	6	38.03	1.44	-
G x R x T	631.03	6	105.17	2.82	-
B x R x T	306.96	12	25.54	0.83	-
G x B x R x T	494.14	12	41.18	1.33	-
B x subjects within groups	1365.58	24	56.90		
R x subjects within groups	536.63	24	22.36		
T x subjects within groups	2161.61	6	60.03		
BR x subjects within groups	1068.66	48	22.26		
BT x subjects within groups	1900.19	72	26.39		
RT x subjects within groups	2648.90	72	37.29		
BRT x subjects within subjects	4456.67	144	30.95		
Total	24683.43	503	49.07		

3.264 analysis, $\underline{F}$ (3,36) = 8.25, $p < .01$. This interaction effect is shown in Fig. 3.8.5 and suggests a similar effect to that obtained in reproduction of horizontal task.

The only third order interaction found statistically significant for this task is a groups x biasing conditions x targets interaction effect: AE, $\underline{F}$ (6,72) = 3.54, $p < .01$. This interaction effect suggests that the groups are differently affected by biasing conditions on different target lengths.

A general conclusion that emerges from the two tasks is that shorter targets are more overestimated and longer targets more underestimated by the blind group than their sighted counterpart. In reproduction of the horizontal task sighted subjects showed more biasing than their blind counterpart. The reason may be that the sighted subjects were not as good as the blind in the use of kinesthetic modality and, therefore, showed more biasing. However, this trend was absent in curvilinear task which involved angular movements. The above results indicate that though the effects of biasing are available in both the blind and sighted subjects, these effects are not identical in them.

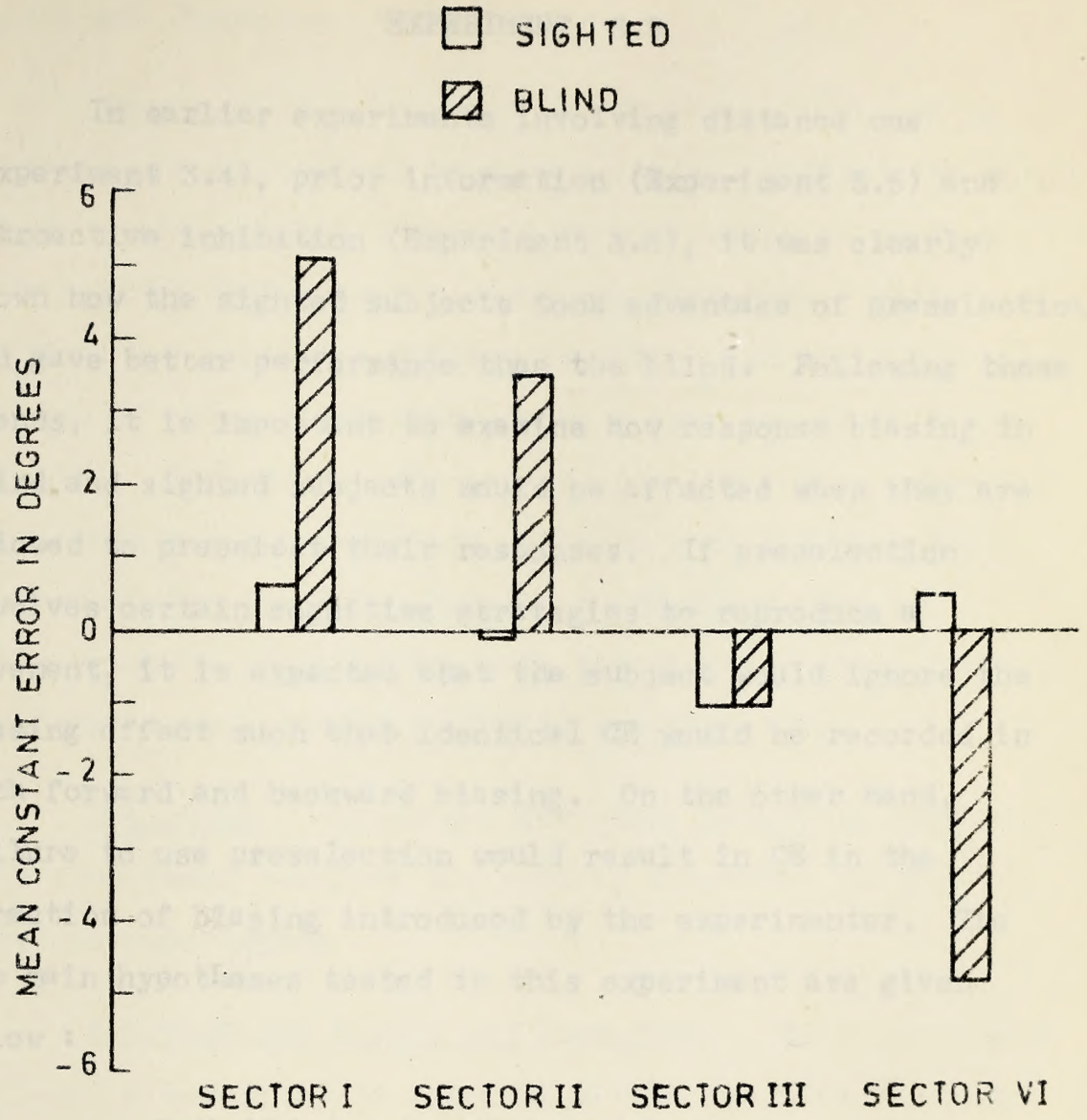


FIG.3.8.5 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF VARIOUS TARGETS

FIG. 3.8.5 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF VARIOUS TARGETS

3.265

EXPERIMENT 3.9

In earlier experiments involving distance cue (Experiment 3.4), prior information (Experiment 3.5) and retroactive inhibition (Experiment 3.6), it was clearly shown how the sighted subjects took advantage of preselection and gave better performance than the blind. Following these trends, it is important to examine how response biasing in blind and sighted subjects would be affected when they are allowed to preselect their responses. If preselection involves certain cognitive strategies to reproduce a movement, it is expected that the subject would ignore the biasing effect such that identical CE would be recorded in both forward and backward biasing. On the other hand, failure to use preselection would result in CE in the direction of biasing introduced by the experimenter. The two main hypotheses tested in this experiment are given below :

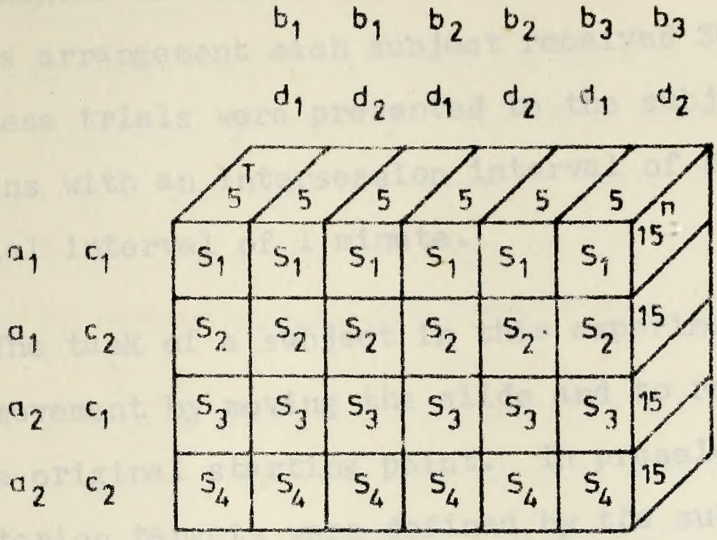
> Both blind and sighted subjects would produce evidence for response biasing in their reproduction of constrained movements.
>
> Given a preselection cue for making a movement, sighted subjects would be less affected by response biasing activity than blind subjects.

3.266 Method and Procedure

Sample. Sixty sighted and 60 congenitally blind subjects participated in this experiment. Sighted and blind subjects were equally divided into two groups to perform either horizontal or curvilinear movement task. These subjects had school or college education and their age ranged between 15 years to 25 years, with a mean age of 20 years 3 months. The groups were matched for their age, education and intelligence. The blind subjects were selected from the school for the blind located in Varanasi city in Uttar Pradesh. Sighted subjects were also selected from the local schools and colleges of the same city.

Apparatus. Apparatus and other materials used in this experiment remained the same as described in the previous experiments.

Experimental Design and Procedure. This experiment followed a 4-way (2 x 2 x 3 x 2) within subjects factorial design. The experimental arrangements of this design appear in Fig. 3.9.1. This included groups (sighted or blind), preselection (preselected or constrained), biasing activities (control, backward or forward) and targets (5 cm to 25 cm or 25 to 45 cm). There were 4 independent groups, i.e., sighted preselected, sighted-constrained, blind-preselected and blind-constrained. Repeated measures were



a-GROUP

1) SIGHTED
2) BLIND

b-BIASING CONDITION

1) CONTROL
2) BACKWARD
3) FORWARD

c-PRESELECTION

1) PRESELECTED
2) CONSTRAINED

d-TARGET

1) SHORT-5 -25cm
2) LONG --25-45cm

N=60 (SIGHTED=30/ BLIND=30)

FIG3.9.1 DESIGN FOR EXPERIMENT 3.9

3.267 taken on the biasing and target conditions. There were 6 experimental treatments and each was tested on 5 trials. With this arrangement each subject received 30 trials in all. These trials were presented to the subjects in 3 sessions with an intersession interval of 5 minutes and intertrial interval of 1 minute.

The task of a subject in this experiment was to learn a hand movement by moving the slide and to reproduce the same from the original starting point. In preselected condition, the criterion targets were defined by the subjects, while in the constrained group subjects received the criterion targets chosen by the subjects of the preselected group.

A biasing movement was also introduced during the learning of criterion responses by asking the subjects to move his hand from the criterion target to an interpolated biasing target indicated by the experimenter. They were asked to return to the original starting point after the lapse of a given retention interval. This procedure is similar to the one described by Stelmach and Walsh (1972). The interpolated movements were $\pm$ 3 cm/25° away from the criterion targets.

Dependent Variables. In this experiment also responses were analysed for AE, VE and CE.

3.268 Results and Discussion

Horizontal Task. AE, VE and CE raw scores obtained in this experiment are presented in Appendices, 3.XXXVIII, 3.XXXIX, 3.XXXX, respectively. The data obtained for this experiment were analysed in terms of means and S.D. of AE, VE and CE. Mean and S.D. scores for AE, VE and CE are reported in Tables 3.9.1, 3.9.2 and 3.9.3, respectively.

A separate 4-way ANOVA test (2 x 2 x 3 x 2) was applied to analyze AE, VE, and CE data separately. A summary of results obtained in the analyses of AE, VE and CE is presented in Tables 3.9.4, 3.9.5 and 3.9.6, respectively.

The main effect of groups is significant for all the three error analyses: AE, F (1,56) = 34.53, $p < .01$; VE, F (1,56) = 155.54, $p < .01$; and CE, F (1,56) = 9.72, $p < .01$. For the sighted and blind groups mean AE scores are 1.54 cm and 2.04 cm, respectively; mean VE scores are 0.73 cm and 1.73 cm, respectively; and mean CE scores are -0.45 cm and 0.06 cm, respectively. An observation of mean scores suggests that the two groups differ in the degree of precision, the sighted group being more precise than the blind group. The sighted group tends to underestimate more than the blind group. These findings also support the results of the previous experiments.

3.269

TABLE 3.9.1

MEAN AE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS (PRE/CON) UNDER BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)
Sighted	Preselected	0.40 (0.16)	1.61 (0.34)	0.45 (0.24)	1.35 (0.37)	0.37 (0.21)	1.70 (0.39)
	Constrained	0.98 (0.28)	2.18 (0.38)	1.67 (0.52)	2.99 (0.64)	1.78 (0.56)	3.05 (0.67)
Blind	Preselected	1.40 (0.44)	1.86 (0.54)	1.88 (0.58)	2.82 (1.13)	1.91 (0.56)	2.27 (0.76)
	Constrained	1.51 (0.36)	2.21 (0.69)	1.60 (0.51)	2.57 (1.18)	2.23 (0.73)	2.23 (0.69)

TABLE 3.9.1

MEAN AE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF SLING AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS (PRE/CON) UNDER RIASING AND TARGET CONDITIONS

Groups	PRE/CON	Control		Reversed		Forward	
		(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
Sighted	Preselected	0.40 (0.16)	1.61 (0.34)	0.45 (0.24)	1.86 (0.37)	0.27 (0.21)	1.70 (0.39)
	Constrained	0.98 (0.28)	2.18 (0.38)	1.67 (0.65)	3.99 (0.64)	1.73 (0.58)	3.08 (0.67)
Blind	Preselected	1.40 (0.44)	1.86 (0.54)	1.89 (0.36)	3.82 (1.13)	1.31 (0.38)	2.09 (0.76)
	Constrained	1.51 (0.36)	2.21 (0.69)	1.86 (0.81)	3.89 (0.18)	0.93 (0.73)	2.25 (0.59)

3.270

TABLE 3.9.2

MEAN VE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS (PRE/CON) UNDER DIFFERENT BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)
Sighted	Preselected	0.44 (0.16)	0.82 (0.31)	0.42 (0.18)	1.07 (0.46)	0.36 (0.13)	0.86 (0.38)
	Constrained	0.95 (0.32)	0.85 (0.34)	0.44 (0.23)	0.97 (0.52)	0.78 (0.58)	0.86 (0.34)
Blind	Preselected	1.33 (0.47)	1.71 (0.61)	1.86 (0.53)	2.74 (1.69)	1.34 (0.68)	2.11 (1.14)
	Constrained	1.19 (0.59)	2.03 (0.55)	1.55 (0.73)	1.75 (0.95)	1.58 (0.64)	1.64 (0.93)

TABLE 3.9.9

MEAN VE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN ANTICIPATION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS (PRE/CON) UNDER DIFFERENT BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		0-25 (cm)	25-45 (cm)	0-25 (cm)	25-45 (cm)	0-25 (cm)	25-45 (cm)
Sighted	Preselected	0.44 (0.16)	0.82 (0.31)	0.42 (0.18)	1.07 (0.46)	0.36 (0.13)	0.86 (0.38)
	Constrained	0.95 (0.32)	0.85 (0.34)	0.44 (0.23)	0.87 (0.32)	0.76 (0.28)	0.85 (0.34)
Blind	Preselected	1.32 (0.47)	1.71 (0.61)	1.86 (0.82)	2.74 (1.80)	1.74 (0.68)	2.11 (1.14)
	Constrained	1.19 (0.59)	2.03 (0.85)	1.65 (0.73)	1.95 (0.82)	1.58 (0.64)	1.64 (0.83)

3.271

TABLE 3.9.3

MEAN CE SCORES (IN CM) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED HORIZONTAL MOVEMENTS (PRE/CON) UNDER DIFFERENT BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)	5-25 (cm)	25-45 (cm)
Sighted	Preselected	-0.03 (0.23)	-1.47 (0.60)	-0.19 (0.28)	-0.77 (0.60)	-0.01 (0.33)	-1.52 (0.62)
	Constrained	0.16 (0.37)	-2.09 (0.47)	-1.64 (0.57)	-2.90 (0.75)	1.64 (0.48)	3.01 (0.72)
Blind	Preselected	0.46 (0.88)	-0.90 (0.90)	-0.42 (1.00)	-1.55 (1.90)	1.04 (1.41)	0.16 (1.38)
	Constrained	1.03 (0.66)	-1.20 (0.89)	-0.21 (0.94)	-1.76 (1.68)	1.73 (0.95)	0.91 (1.51)

3.272

TABLE 3.9.4

SUMMARY OF ANOVA OBTAINED FOR CE ON HORIZONTAL TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	102.00	59			
Groups (G)	13.95	1	13.95	9.72	.01
Preselection (P)	7.66	1	7.66	5.33	.05
G x P	0.00	1	0.00	0.00	-
Subjects within groups	80.39	56	1.44		
Within subjects	873.67	300			
Biasing activities (B)	251.89	2	125.94	146.25	.01
G x B	4.57	2	2.29	2.65	-
B x P	130.73	2	65.36	75.90	.01
G x P x B	72.33	2	36.17	42.00	.01
B x subjects within groups	96.45	112	0.86		
Targets (T)	122.85	1	122.85	173.86	.01
G x T	2.33	1	2.33	3.30	-
P x T	0.17	1	0.17	0.24	-
G x P x T	5.56	1	5.56	7.87	.01
T x subjects within groups	39.57	56	0.71		
B x T	27.73	2	13.86	18.21	.01
G x B x T	2.71	2	1.36	1.78	-
B x P x T	22.19	2	11.09	14.57	.01
G x B x P x T	9.34	2	4.67	6.14	.01
BT x subjects within groups	85.26	112	6.76		
Total	975.67	359			

TABLE 3.9.4

SUMMARY OF ANOVA OBTAINED FOR CF ON HORIZONTAL TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects					
Groups (G)					
Preselection (P)					
G x P					
Subjects within groups					
Within subjects					
Blasting activities (B)					
G x B					
B x P					
G x P x B					
B x subjects within groups					
Targets (T)					
G x T					
P x T					
G x P x T					
T x subjects within groups					
B x T					
G x B x T					
B x P x T					
G x B x P x T					
BT x subjects within groups					
Total					

3.273

TABLE 3.9.5

SUMMARY OF ANOVA OBTAINED FOR AE ON HORIZONTAL TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	115.41	59			
Subjects (G)	22.13	1	22.13	34.53	.01
Preselection (P)	30.57	1	30.57	47.69	.01
G x P	26.82	1	26.82	41.84	.01
Subjects within groups	35.89	56	0.64		
Within subjects	191.72	300			
Biasing activities (B)	13.48	2	6.74	24.42	.01
G x B	0.53	2	0.27	0.96	-
B x P	1.87	2	0.93	3.38	.05
G x P x B	7.14	2	3.57	12.94	.01
B x subjects within groups	30.91	112	0.28		
Targets (T)	71.41	1	71.41	180.80	.01
G x T	8.94	1	8.94	22.64	.01
P x T	0.05	1	0.05	0.12	-
G x P x T	0.11	1	0.11	0.28	-
T x subjects within groups	22.12	56	0.39		
B x T	1.28	2	0.64	2.46	-
G x B x T	3.50	2	1.75	6.72	.01
B x P x T	0.75	2	0.38	1.44	-
G x B x P x T	0.46	2	0.23	0.88	-
BT x subjects within groups	29.17	112	0.26		
Total	307.13	359			

TABLE 3.9.5

SUMMARY OF ANOVA OBTAINED FOR AE ON HORIZONTAL TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	113.41	59			
Subjects (C)	29.15	1	29.15	34.53	.01
Preselection (P)	30.57	1	30.57	47.89	.01
C x P	26.82	1	26.82	41.84	.01
Subjects within groups	35.89	56	0.64		
Within subjects	161.75	300			
Blasing activities (B)	13.48	2	6.74	24.42	.01
C x B	0.53	2	0.27	0.96	-
B x P	1.87	2	0.93	3.38	.05
C x P x B	7.14	2	3.57	12.94	.01
B x subjects within groups	30.91	112	0.28		
Targets (T)	71.41	1	71.41	180.80	.01
C x T	8.04	1	8.04	20.36	.01
P x T	0.05	1	0.05	0.13	-
C x P x T	0.11	1	0.11	0.28	-
T x subjects within groups	22.12	56	0.39		
B x T	1.28	2	0.64	2.46	-
C x B x T	3.50	2	1.75	6.72	.01
P x B x T	0.75	2	0.38	1.44	-
C x B x P x T	0.46	2	0.23	0.88	-
BT x subjects within groups	29.17	112	0.26		
Total	307.13	359			

.274

TABLE 3.9.6

SUMMARY OF ANOVA OBTAINED FOR VE ON HORIZONTAL TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	125.63	59			
Groups (G)	89.99	1	89.99	155.54	.01
Preselection (P)	0.14	1	0.14	0.24	-
G x P	3.10	1	3.10	5.36	.05
Subjects within groups	32.40	56	0.58		
Within subjects	148.77	300			
Biasing Activities (B)	2.38	2	1.19	3.10	.05
G x B	3.03	2	1.52	3.96	.05
B x P	4.44	2	2.22	5.81	.01
G x P x B	0.72	2	0.36	0.94	-
B x subjects within groups	42.87	112	0.38		
Targets (T)	16.82	1	16.82	31.53	.01
G x T	0.74	1	0.74	1.39	-
P x T	2.42	1	2.42	4.54	.05
G x P x T	0.01	1	0.01	0.01	-
T x subjects within groups	29.88	56	0.53		
B x T	0.82	2	0.41	1.14	-
G x B x T	1.08	2	0.54	1.51	-
B x P x T	1.23	2	0.61	1.72	-
G x B x P x T	2.38	2	1.19	3.34	.05
BT x subjects within groups	39.95	112	0.36		
Total	274.39	359			

SUMMARY OF ANOVA OVERALL FOR VS ON HORIZONTAL
TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	128.63	59			
Groups (G)	89.89	1	89.89	198.84	.01
Preselection (P)	0.14	1	0.14	0.34	-
G x P	3.10	1	3.10	6.86	.05
Subjects within groups	35.40	56	0.63		
Within subjects	148.77	60			
Biasing Activities (B)	2.52	2	1.16	3.10	.05
G x B	3.03	2	1.52	3.86	.05
B x P	1.44	2	2.52	5.81	.01
G x P x B	0.72	2	0.36	0.84	-
B x subjects within groups	42.87	112	0.38		
Targets (T)	16.82	1	16.82	31.55	.01
G x T	0.74	1	0.74	1.39	-
P x T	2.42	1	2.42	4.54	.05
G x P x T	0.01	1	0.01	0.01	-
T x subjects within groups	29.85	56	0.53		
B x T	0.82	2	0.41	1.14	-
G x B x T	1.08	2	0.54	1.51	-
B x P x T	1.85	2	0.91	1.72	-
G x B x P x T	2.38	2	1.19	3.74	.05
BT x subjects within groups	59.95	112	0.36		
Total	274.30	359			

3.275 The main effect of preselection is significant for AE, $\underline{F}$ (1,56) = 47.69, $p < .01$; and CE, $\underline{F}$ (1,56) = 5.33, $p < .05$. It is noted that the preselected movements (mean AE = 1.50 cm) are better retained than the constrained (Mean AE = 2.08 cm). It is evident in the CE analysis that the preselected movements (Mean CE = -0.40 cm) tends to be more underestimated than the constrained movement (Mean CE = -0.11 cm). These results support the contention regarding facilitatory effect of preselection in coding of movements.

The biasing conditions show significant effect in all the three recall error analyses: AE, $\underline{F}$ (2,112) = 24.42, $p < .01$; VE, $\underline{F}$ (2,112) = 3.10, $p < .05$; and CE, $\underline{F}$ (2,112) = 146.25, $p < .01$. For control, backward and forward biasing conditions mean AE scores are 1.51 cm, 1.92 cm, and 1.94 cm, respectively; mean VE scores are 1.16 cm, 1.35 cm, and 1.19 cm, respectively; and mean CE scores are -0.51 cm, -1.32 cm, and 0.87 cm, respectively. These results show that recall responses shift in the direction of the magnitude of interpolated movement, i.e. interpolated movement of magnitude shorter than the criterion causes underestimation, while interpolated movement of magnitude longer than the criterion causes overestimation. These results corroborate findings of Stelmach and Walsh (1972), and Stelmach, et al (1976).

.276 The main effect of targets has also been found significant for AE, F (1,56) = 180.80, $p < .01$; VE, F (1,56) = 31.53, $p < .01$; and CE, F (1,56) = 173.86, $p < .01$. For short and long targets, mean AE scores are 1.35 cm and 2.24 cm, respectively; mean VE scores are 1.02 cm and 1.45 cm, respectively; and mean CE scores are 0.33 cm and -0.84 cm, respectively. These results are consistent with those observed in Experiments 3.4 and 3.5. While AE and VE analyses show that short targets are more precisely coded than long ones. CE analysis portrays that short targets are overestimated and long targets underestimated.

Tables 3.9.4, 3.9.5 and 3.9.6 show that several first order interaction effect are significant. The groups x preselection interaction effect is significant for AE, F (1,56) = 41.84, $p < .01$; and VE, F (1,56) = 5.36, $p < .05$. Fig. 3.9.2 shows that groups differ in reproduction of preselected movements but not in reproduction of constrained movements. VE data show that the sighted subjects perform better in preselected condition, while the blind subjects perform better in constrained condition. These analyses once again confirm that the sighted group has an advantage of visual experience in the coding of preselected movements. In contrast, the preselection cue is not beneficial to the blind group for coding movements.

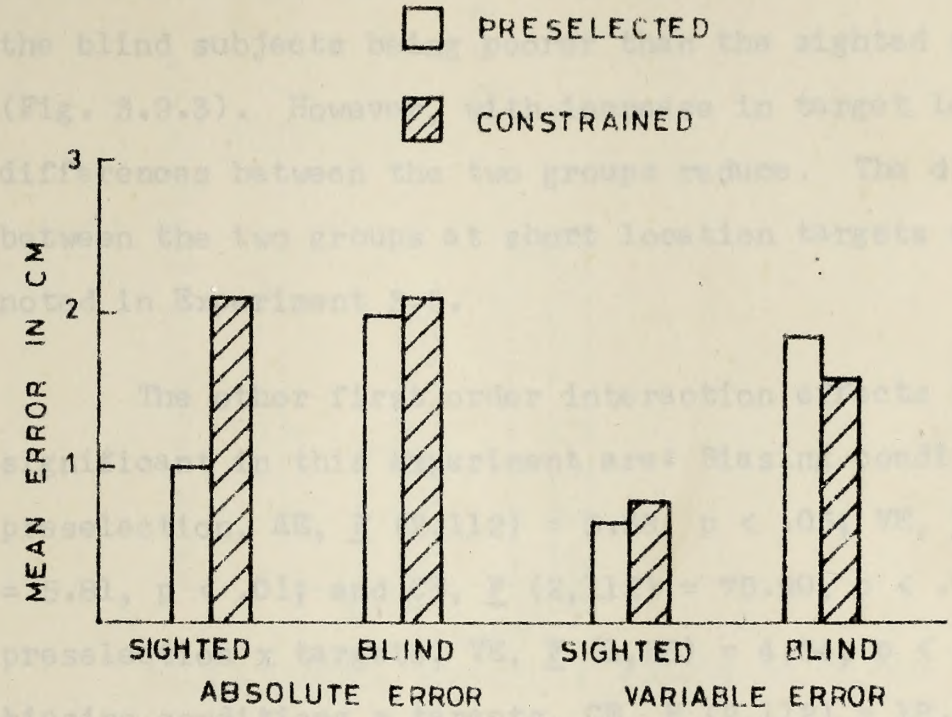
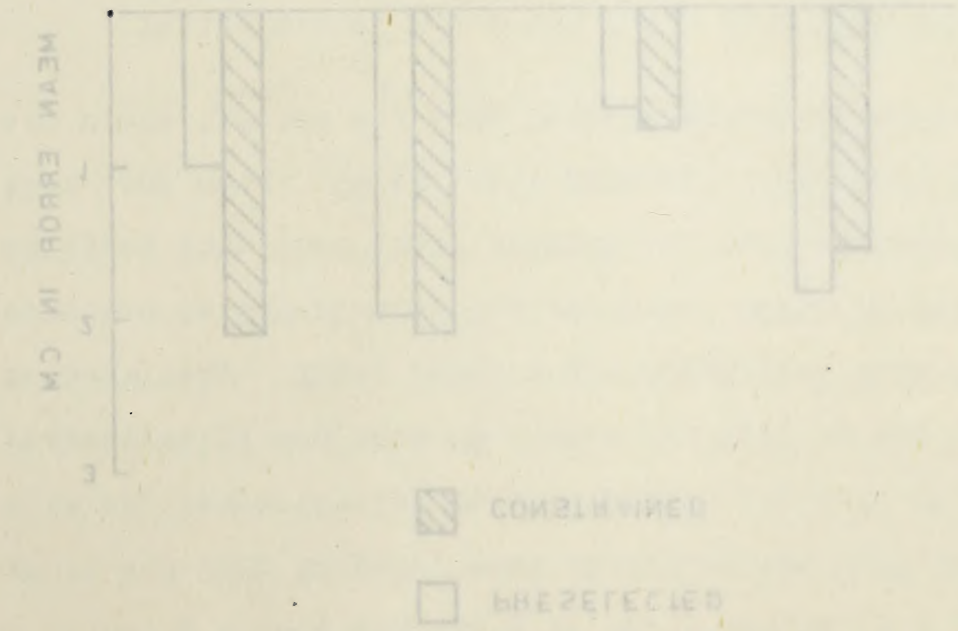


FIG.3.9.2 MEAN ABSOLUTE AND VARIABLE ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS


SIGHTED
BLIND
SIGHTED
BLIND
1
3
CONSTRAINED
UNRESTRICTED

3.277 The groups x targets interaction is significant in AE analysis alone, F (1,56) = 22.64, $p < .01$. This interaction effect indicates that the two groups differ on short targets, the blind subjects being poorer than the sighted subjects (Fig. 3.9.3). However, with increase in target length the differences between the two groups reduce. The difference between the two groups at short location targets was also noted in Experiment 3.5.

The other first order interaction effects found significant in this experiment are: Biasing conditions x preselection, AE, F (2,112) = 3.38, $p < .05$; VE, F (2,112) = 5.81, $p < .01$; and CE, F (2,112) = 75.90, $p < .01$; preselection x targets, VE, F (1,56) = 4.54, $p < .05$; and biasing conditions x targets, CE, F (2,112) = 18.21, $p < .01$. These effects indicate how one variable of the present experimental design influences the other variables.

Three second order interaction effects have also been found significant. The most interesting among these is a groups x preselection x biasing conditions interaction effect which is significant in AE, F (2,112) = 12.94, $p < .01$; and CE, F (2,112) = 42.00, $p < .01$, analyses. Mean AE and CE scores for this interaction effect have been plotted in Fig. 3.9.4. This figure shows that the sighted subjects are affected adversely by biasing activity in their reproduction of constrained movements only, while the blind

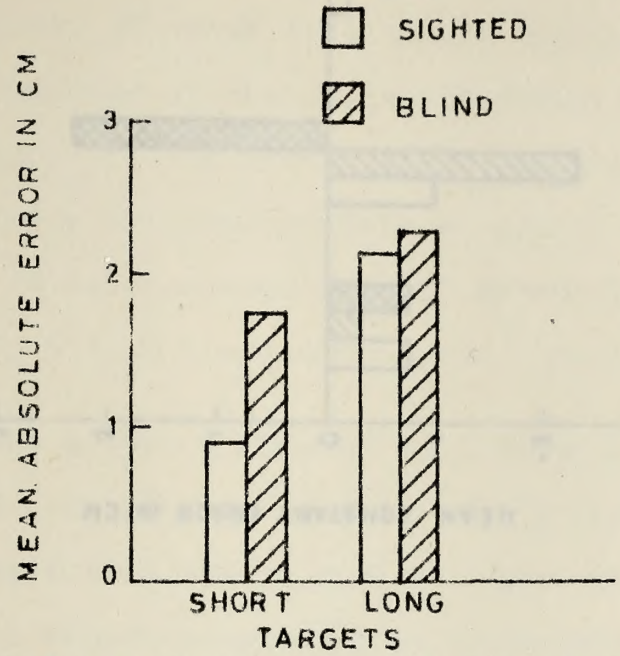
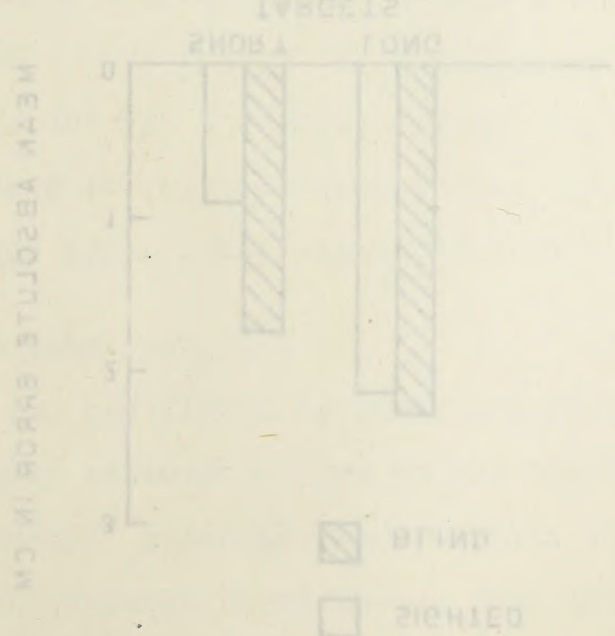


FIG.3.9.3 MEAN ABSOLUTE ERROR OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF SHORT AND LONG MOVEMENTS


SHORT
LONG
0
1
2
3
BLIND
SIGHTED

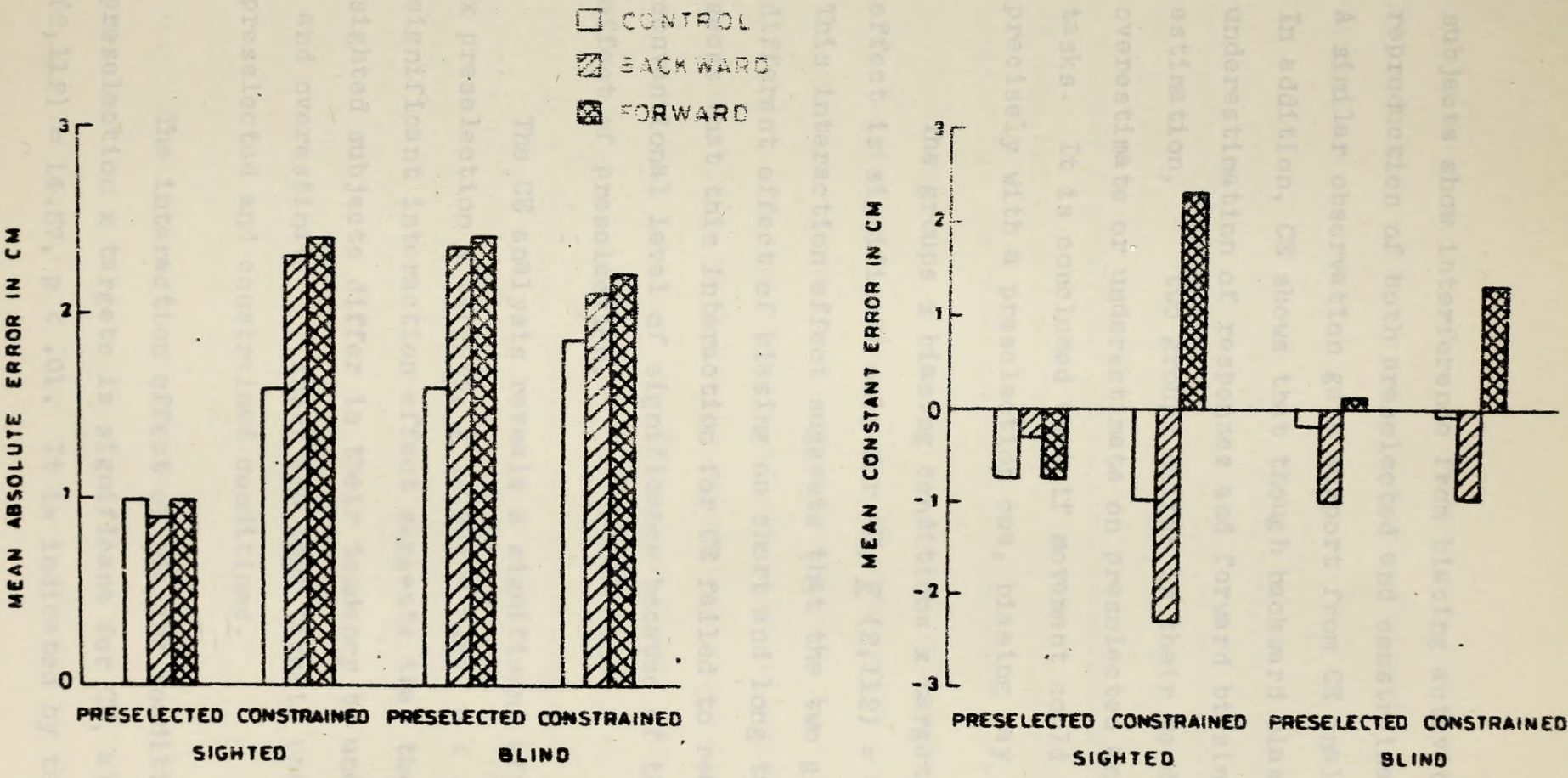


FIG. 3·9·4. MEAN ABSOLUTE AND CONSTANT ERRORS OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS UNDER DIFFERENT RESPONSE BIASING CONDITIONS

FIG. 2-8-7 MEAN ABSOLUTE AND CONSTANT ERROR TO BLIND AND SIGHTED GROUPS IN RESPONSE TO PRESELECTED AND CONSTRAINED MOVEMENT UNDER VERY RESTRICTED CONDITIONS OF PRODUCTION

DIFFERENT RESPONSE BIASING CONDITIONS

3.278 subjects show interference from biasing activity in reproduction of both preselected and constrained movements. A similar observation gets support from CE analysis also. In addition, CE shows that though backward biasing causes underestimation of responses and forward biasing overestimation, two groups differ in their tendency to overestimate or underestimate on preselected and constrained tasks. It is concluded that if movement could be coded precisely with a preselection cue, biasing may not occur.

The groups x biasing conditions x targets interaction effect is significant only for AE, F (2,112) = 6.72, $p < .01$. This interaction effect suggests that the two groups show different effect of biasing on short and long targets. It seems that this interaction for CE failed to reach conventional level of significance because of the concurrent effect of preselection.

The CE analysis reveals a significant effect of groups x preselection x targets, F (1,56) = 7.87, $p < .01$. This significant interaction effect suggests that the blind and sighted subjects differ in their tendency to underestimate and overestimate short and long targets under preselected and constrained conditions.

The interaction effect of biasing conditions x preselection x targets is significant for CE, alone, F (2,112) = 14.57, $p < .01$. It is indicated by this interaction

3.279 effect that short and long targets are differently affected by biasing activities under preselected and constrained conditions.

Lastly, the groups x preselection x biasing conditions x targets interaction effect has also been found significant: VE, $\underline{F}$ (2,112) = 3.34, $p < .05$; and CE, $\underline{F}$ (2,112) = 6.14, $p < .01$. Figure 3.9.5 shows this interaction effect. The VE data indicate that the effect of biasing activity is not similar for the blind and sighted subjects in reproduction of short and long movements presented with and without preselection cue. Analysis of CE data would be more interesting to show the directional shift in error (response biasing). In reproduction of short preselected movements, only the blind subjects show directional biasing. In reproduction of long preselected movements, the sighted subjects show underestimation in both backward and forward biasing conditions, whereas the blind subjects show a strong effect of backward biasing but only a weak effect of forward biasing. In case of short constrained movements the sighted subjects show usual response biasing effect in both backward and forward conditions but responses of the blind subjects differ. In case of long constrained movements sighted subjects show usual directional shift in error due to the biasing but blind subjects show effects of strong backward and weak forward biasing. It may be concluded that responses of blind subjects are determined by both biasing

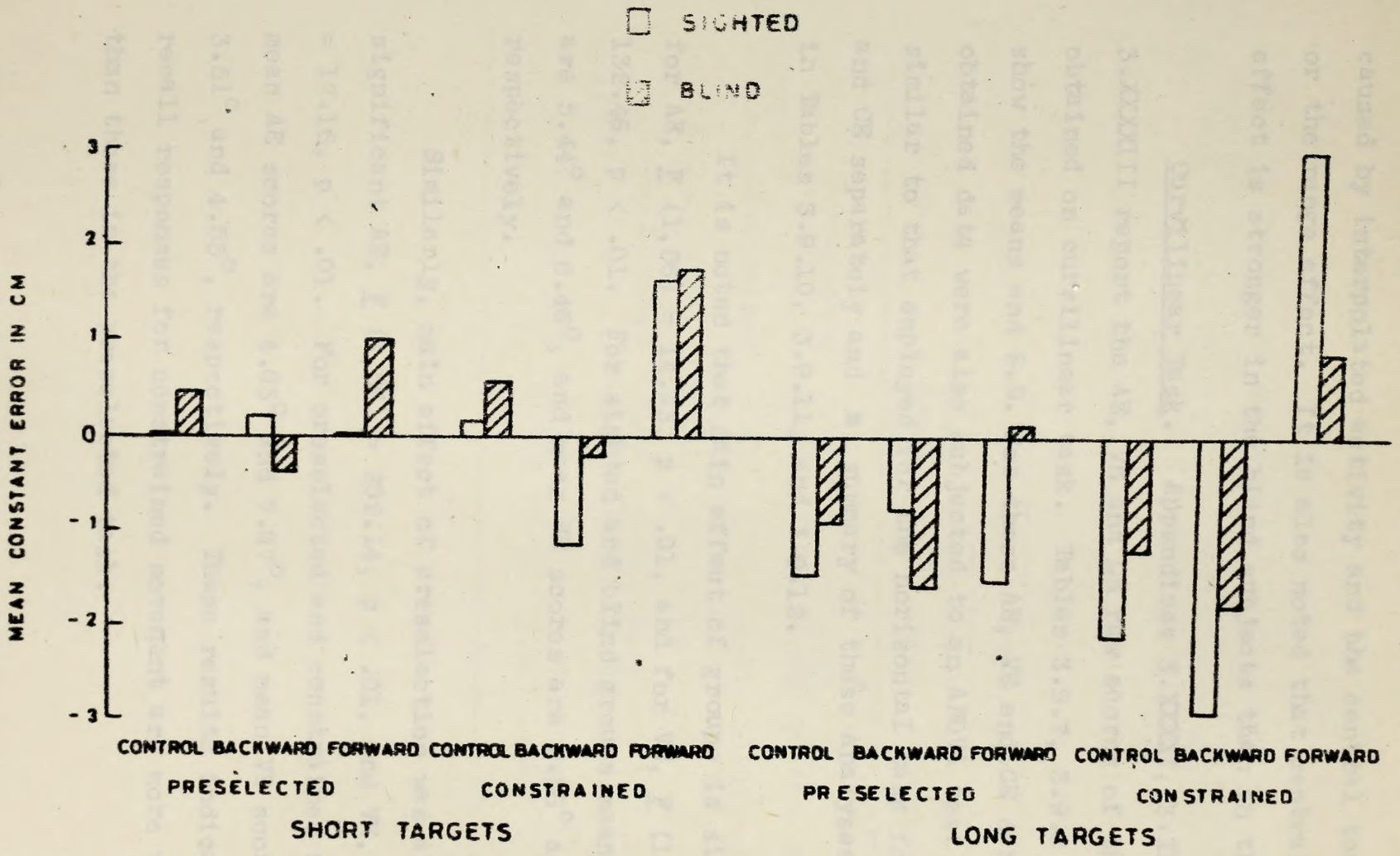


FIG. 3·9·5. MEAN CONSTANT ERRORS OF BLIND AND SIGHTED SUBJECTS AS A FUNCTION OF BIASING ACTIVITIES IN REPRODUCTION OF SHORT/LONG PRESELECTED AND CONSTRAINED MOVEMENTS.

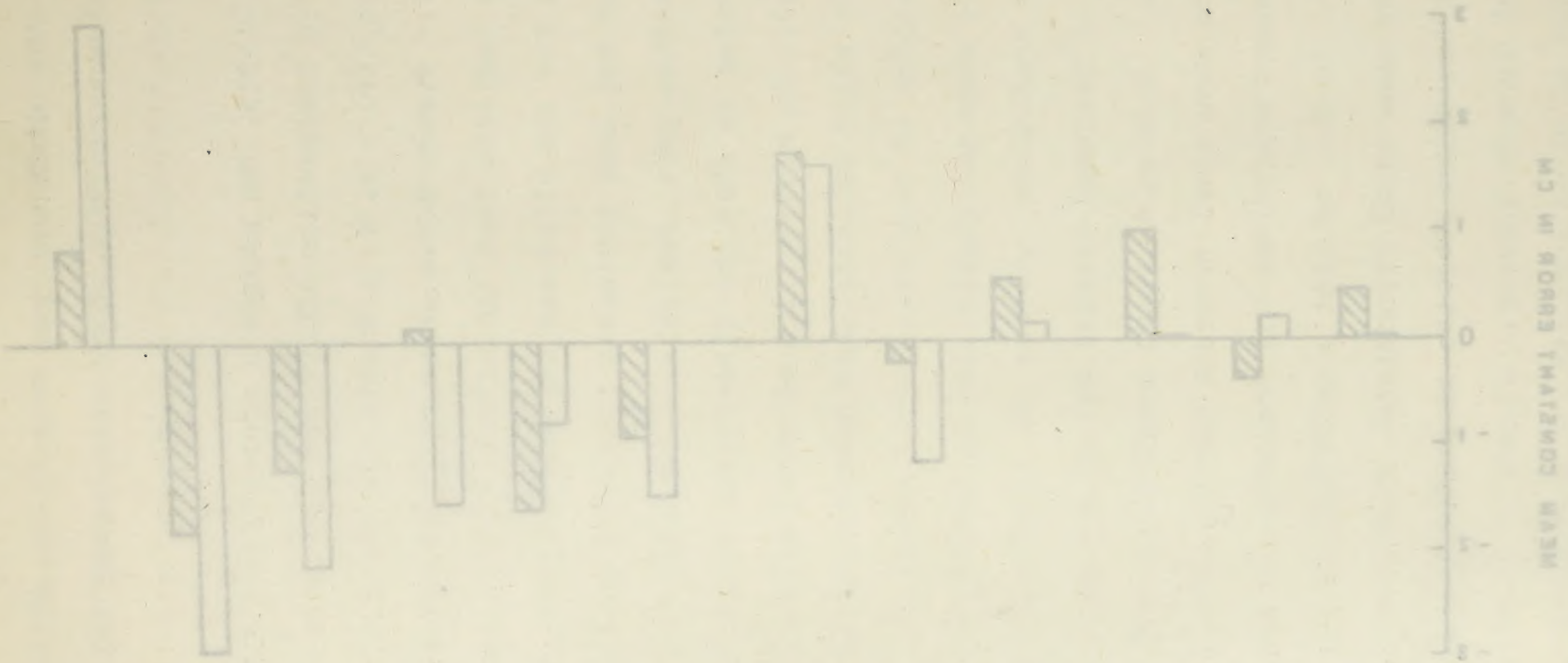


FIG. 3·3·5. MEAN CONSTANT ERRORS OF BLIND AND SIGHTED SUBJECTS AS A FUNCTION OF BIASING ACTIVITIES IN REPRODUCTION OF SHORT/LONG PRESELECTED AND CONSTRAINED MOVEMENTS.

3.280 caused by interpolated activity and the central tendency or the range effect. It is also noted that central tendency effect is stronger in the blind subjects than in the sighted.

Curvilinear Task. Appendices 3.XXXXI, 3.XXXXII and 3.XXXXIII report the AE, VE and CE raw scores of the subjects obtained on curvilinear task. Tables 3.9.7, 3.9.8 and 3.9.9 show the means and S.D. for these AE, VE and CE data. The obtained data were also subjected to an ANOVA test performed similar to that employed for the horizontal task for AE, VE and CE separately and a summary of these analyses are reported in Tables 3.9.10, 3.9.11, and 3.9.12.

It is noted that main effect of groups is significant for AE, F (1,56) = 14.43, $p < .01$, and for VE, F (1,56) = 132.46, $p < .01$. For sighted and blind groups mean AE scores are 5.44° and 6.46°, and mean VE scores are 2.58° and 5.48°, respectively.

Similarly, main effect of preselection was also significant AE, F (1,56) = 202.14, $p < .01$, and VE, F (1,56) = 17.16, $p < .01$. For preselected and constrained movements mean AE scores are 4.03° and 7.87°, and mean VE scores are 3.51° and 4.55°, respectively. These results indicate that recall responses for constrained movement are more variable than those in the preselected task.

3.281

TABLE 3.9.7

MEAN AE SCORES (IN DEGREES) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED (PRE/CON) CURVILINEAR MOVEMENTS UNDER BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing conditions					
		Control		Backward		Forward	
		60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)
Sighted	Preselected	1.65 (1.02)	3.52 (0.68)	1.53 (0.63)	3.65 (0.66)	1.40 (0.58)	3.32 (0.85)
	Constrained	4.61 (1.20)	6.61 (0.68)	8.61 (1.33)	10.37 (1.32)	8.48 (1.17)	11.51 (1.15)
Blind	Preselected	3.69 (1.25)	4.05 (1.39)	6.27 (2.61)	7.51 (3.73)	5.61 (2.30)	6.20 (2.65)
	Constrained	6.85 (2.71)	7.01 (2.77)	7.99 (2.93)	7.63 (4.01)	6.71 (2.30)	8.05 (3.36)

3.282

TABLE 3.9.8

MEAN VE SCORES (IN DEGREES) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED (PRE/CON) CURVILINEAR MOVEMENTS UNDER BIASING AND TARGET CONDITIONS

Group	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)
Sighted	Preselected	1.41 (0.40)	2.42 (0.86)	1.56 (0.62)	2.85 (1.02)	1.67 (0.90)	2.98 (0.79)
	Constrained	3.89 (1.44)	4.51 (2.03)	2.18 (1.55)	2.79 (1.37)	1.64 (0.49)	3.08 (1.74)
Blind	Preselected	3.64 (1.49)	3.71 (1.26)	5.61 (1.49)	6.09 (2.64)	4.89 (2.52)	5.24 (2.11)
	Constrained	5.56 (2.39)	5.97 (2.35)	5.35 (1.94)	7.01 (3.93)	5.84 (2.42)	6.82 (3.61)

3.283

TABLE 3.9.9

MEAN CE SCORES (IN DEGREES) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED (PRE/CON) CURVILINEAR MOVEMENTS UNDER BIASING AND TARGET CONDITIONS

Groups	PRE/CON	Biasing Conditions					
		Control		Backward		Forward	
		60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)	60-90 (deg)	90-120 (deg)
Sighted	Preselected	-1.07 (1.34)	-2.72 (1.39)	-0.55 (0.89)	-2.32 (1.51)	-0.47 (0.97)	-1.88 (1.49
	Constrained	-2.19 (1.93)	-4.00 (3.02)	-8.24 (2.30)	-10.16 (1.64)	8.48 (1.17)	11.29 (1.26)
Blind	Preselected	-1.88 (1.56)	-2.37 (1.62)	-4.05 (3.82)	-5.35 (4.84)	1.59 (4.28)	0.73 (5.17)
	Constrained	-3.41 (4.95)	-2.00 (5.17)	-3.27 (6.81)	-4.21 (3.61)	2.12 (5.00)	1.20 (5.77)

3.284

TABLE 3.9.10

SUMMARY OF ANOVA OBTAINED FOR AE ON CURVILINEAR TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	2151.79	59			
Groups (G)	94.50	1	94.50	14.43	.01
Preselection (P)	1324.08	1	1328.08	202.14	.01
G x P	366.38	56			
Subjects within groups	366.82	56	6.55		
Within subjects	1830.79	300			
Biasing activities (B)	269.37	2	132.18	37.74	.01
G x B	13.95	2	6.97	1.99	-
B x P	34.41	2	17.20	4.91	-
G x P x B	186.41	2	93.21	26.61	.01
B x subjects within groups	392.30	112	3.50		
Targets (T)	160.58	1	160.58	36.83	.01
G x T	54.71	1	54.71	12.55	.01
P x T	0.00	1	0.00	0.00	-
G x P x T	2.35	1	2.35	0.54	-
T x subjects within groups	244.16	56	4.36		
B x T	6.73	2	3.37	0.83	-
G x B x T	0.20	2	0.10	0.02	-
B x P x T	13.77	2	6.89	1.69	-
G x B x P x T	0.97	2	0.48	0.12	-
BT x subjects within groups	455.88	112	4.07		
Total	3982.58	359			

TABLE 3.3.10

SUMMARY OF ANOVA OBTAINED FOR AS ON CURVILINEAR TASK IN EXPERIMENT 3.3

Source	SS	df	MS	F	P
Between subjects					
Groups (G)					
Preselection (P)					
G x P					
Subjects within groups					
Within subjects					
Rating activities (R)					
G x R					
R x P					
G x P x R					
R x subjects within groups					
Targets (T)					
G x T					
P x T					
G x P x T					
T x subjects within groups					
R x T					
G x R x T					
R x P x T					
G x R x P x T					
RT x subjects within groups					
Total					

3.285

TABLE 3.9.11

SUMMARY OF ANOVA OBTAINED FOR VE ON CURVILINEAR TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	1177.25	59			
Groups (G)	756.42	1	756.42	132.46	.01
Preselection (P)	97.97	1	97.97	17.16	.01
G x P	3.06	1	3.06	0.54	-
Subjects within groups	319.79	56	5.71		
Within subjects	1175.05	300			
Biasing activities (B)	5.21	2	2.61	0.95	-
G x B	69.18	2	34.59	12.58	.01
B x P	59.46	2	29.73	10.81	.01
G x P x B	8.64	2	4.32	1.57	-
B x subjects within groups	308.07	112	2.75		
Targets (T)	64.93	1	64.93	18.95	.01
G x T	3.24	1	3.24	0.95	-
P x T	0.85	1	0.85	0.25	-
G x P x T	6.17	1	6.17	1.80	-
T x subjects within groups	191.89	56	3.43		
B x T	4.98	2	2.49	0.62	-
G x B x T	3.02	2	1.51	0.38	-
B x P x T	0.78	2	0.39	0.10	-
G x B x P x T	1.91	2	0.96	0.24	-
BT x subjects within groups	446.76	112	3.99		
Total	2352.30	359			

TABLE 3.9.11

SUMMARY OF ANOVA OBTAINED FOR VS ON CURVILINEAR TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects					
Groups (G)					
Preselection (P)					
G x P					
Subjects within groups					
Within subjects					
Blasting activities (B)					
G x B					
B x P					
G x P x B					
B x subjects within groups					
Targets (T)					
G x T					
P x T					
G x P x T					
T x subjects within groups					
B x T					
G x B x T					
B x P x T					
G x B x P x T					
BT x subjects within groups					
Total					

3.286

TABLE 3.9.12

SUMMARY OF ANOVA OBTAINED FOR CE ON CURVILINEAR TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	p
Between subjects	1008.29	59			
Groups (G)	31.46	1	31.46	1.85	-
Preselection (P)	22.11	1	22.11	1.30	-
G x P	3.67	1	3.67	0.22	-
Subjects within groups	951.05	56	16.98		
Within subjects	10056.77	300			
Biasing activities (B)	3695.89	2	1847.94	173.77	.01
G x B	265.29	2	132.64	12.47	.01
B x P	1351.39	2	675.69	63.54	.01
G x P x B	1406.70	2	703.35	66.14	.01
B x subjects within groups	1191.09	112	10.63		
Targets (T)	49.00	1	49.00	3.11	-
G x T	4.44	1	4.44	0.28	-
P x T	23.30	1	23.30	1.48	-
G x P x T	1.88	1	1.88	0.12	-
T x subjects within groups	881.48	56	15.74		
B x T	29.44	2	14.72	1.58	-
G x B x T	54.48	2	27.24	2.92	-
B x P x T	14.94	2	7.47	0.80	-
G x B x P x T	41.15	2	20.57	2.20	-
BT x subjects within groups	1046.32	112	9.34		
Total	11065.05	359			

TABLE 3.9.12

SUMMARY OF ANOVA OBTAINED FOR CR ON CURVILINEAR TASK IN EXPERIMENT 3.9

Source	SS	df	MS	F	P
Between subjects	1008.29	59			
Groups (G)	31.46	1	31.46	1.85	-
Preselection (P)	22.11	1	22.11	1.30	-
G x P	3.67	1	3.67	0.22	-
Subjects within groups	951.05	56	16.98		
Within subjects	10056.77	300			
Biasing activities (B)	3695.80	3	1847.64	174.77	.01
G x B	265.29	3	132.64	12.47	.01
B x P	1351.39	3	675.69	63.59	.01
G x P x B	1406.70	3	703.35	66.14	.01
B x subjects within groups	1191.05	112	10.63		
Targets (T)	49.00	1	49.00	3.11	-
G x T	4.44	1	4.44	0.28	-
P x T	23.30	1	23.30	1.48	-
G x P x T	1.88	1	1.88	0.12	-
T x subjects within groups	881.48	56	15.74		
B x T	29.44	3	14.72	1.80	-
G x B x T	54.48	3	27.24	3.32	-
B x P x T	14.94	3	7.47	0.80	-
G x B x P x T	41.16	3	20.58	2.50	-
BT x subjects within groups	1046.32	112	9.34		
Total	11068.06	359			

3.287 Results reveal that biasing activity is a significant factor in explaining the forgetting of movements: AE, $\underline{F}$ (2,112) = 37.74, $p < .01$; and CE, $\underline{F}$ (2,112) = 173.77, $p < .01$. For control, backward and forward biasing activities mean AE scores are 4.75°, 6.69° and 4.61°; and mean CE scores -2.45°, -4.77° and 2.88°, respectively. These results are very similar to that obtained in the reproduction of horizontal task in this experiment, and support the findings reported in the earlier experiments on related issues.

Main effect of targets is significant for AE, $\underline{F}(1,56)$ = 36.83, $p < .01$, and CE, $\underline{F}$ (1,56) = 18.95, $p < .01$. For short and long targets mean AE scores are 5.28° and 6.62°, and mean VE scores are 3.60° and 4.45°, respectively. These results suggest higher variability for long targets.

A groups x preselection interaction effect is significant in AE analysis: $\underline{F}$ (1,56) = 55.93, $p < .01$. Like the results obtained for the horizontal task, in this one also the preselected blind group is poorer than the sighted, while the performance of the two groups reversed on the constrained task (see Fig. 3.9.6).

A groups x biasing activity interaction is significant in CE analysis: $\underline{F}$ (2,112) = 12.47, $p < .01$. Mean scores for this interaction effect are presented in Fig. 3.9.7. It suggests that sighted subjects show a stronger tendency of biasing than that of the blind subjects. Similar response trend was also observed in Experiment 3.8.

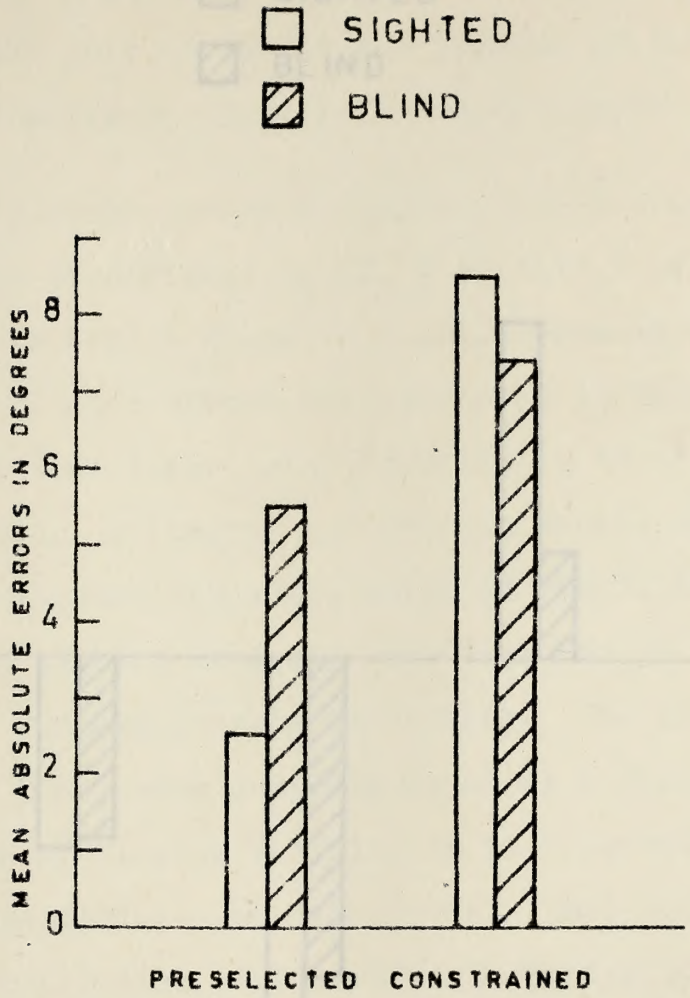


FIG.3.9 6 SHOWING MEAN ABSOLUTE ERRORS OF SIGHTED AND BLIND SUBJECTS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS

FIG.3.9 SHOWING MEAN ABSOLUTE ERRORS OF SIGHTED AND BLIND SUBJECTS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED MOVEMENTS

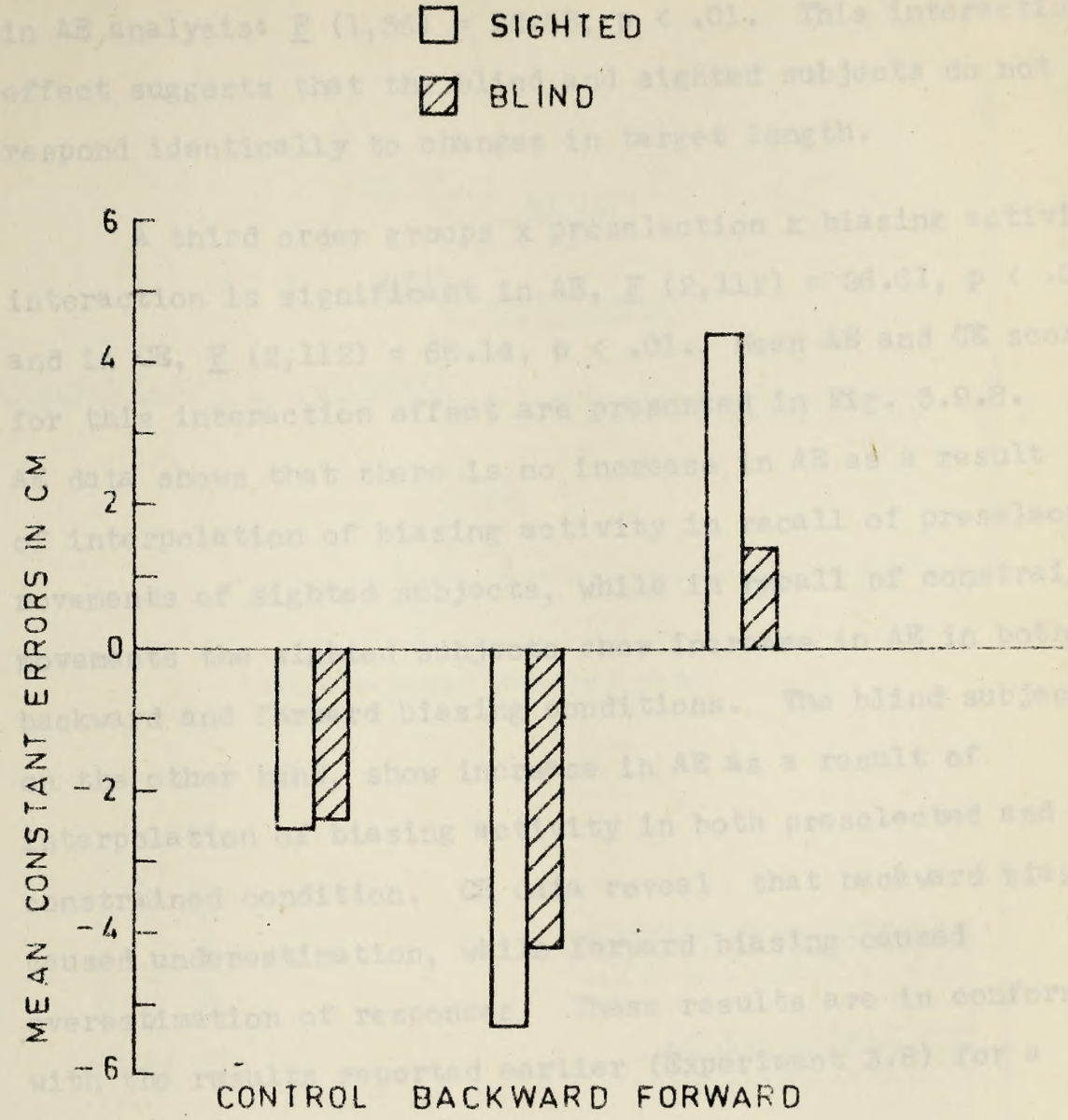


FIG.3.9.7 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS IN REPRODUCTION OF MOVEMENTS UNDER DIFFERENT BIASING CONDITIONS

FIG.3.3.7 SHOWING MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS IN REPRODUCTION OF MOVEMENTS UNDER DIFFERENT BIASING CONDITIONS

3.288 A groups x targets interaction effect is significant in AE analysis: F (1,56) = 12.55, $p < .01$. This interaction effect suggests that the blind and sighted subjects do not respond identically to changes in target length.

A third order groups x preselection x biasing activity interaction is significant in AE, F (2,112) = 26.61, $p < .01$ and in CE, F (2,112) = 66.14, $p < .01$. Mean AE and CE scores for this interaction effect are presented in Fig. 3.9.8. AE data shows that there is no increase in AE as a result of interpolation of biasing activity in recall of preselected movements of sighted subjects, while in recall of constrained movements the sighted subjects show increase in AE in both backward and forward biasing conditions. The blind subjects, on the other hand, show increase in AE as a result of interpolation of biasing activity in both preselected and constrained condition. CE data reveal that backward biasing caused underestimation, while forward biasing caused overestimation of responses. These results are in conformity with the results reported earlier (Experiment 3.8) for a similar task.

Results obtained in this experiment on the recall of horizontal and curvilinear movements show similarity in results regarding groups x preselection x biasing conditions interaction effect. Blind subjects are generally being affected by biasing activities in recall of both preselected

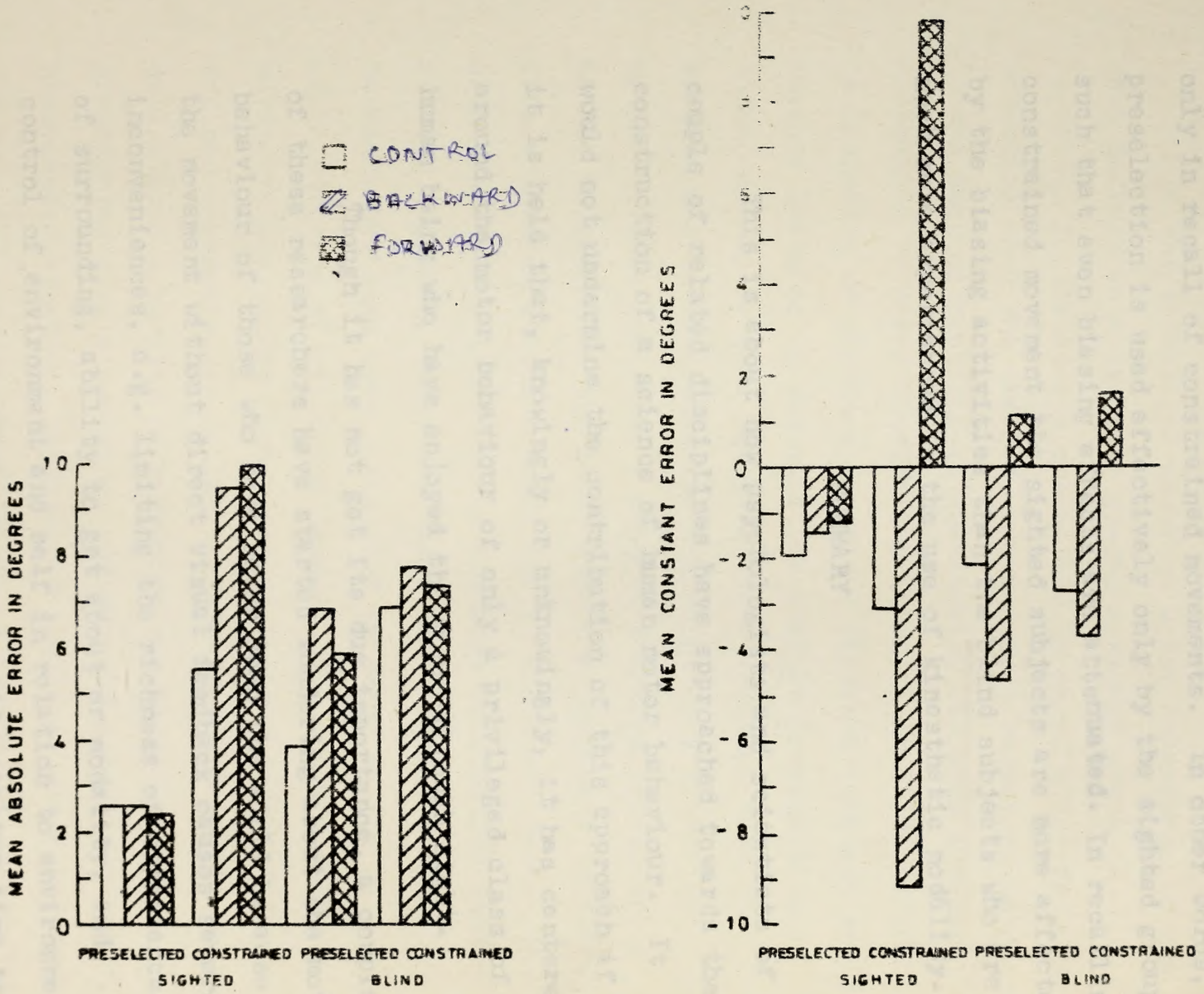
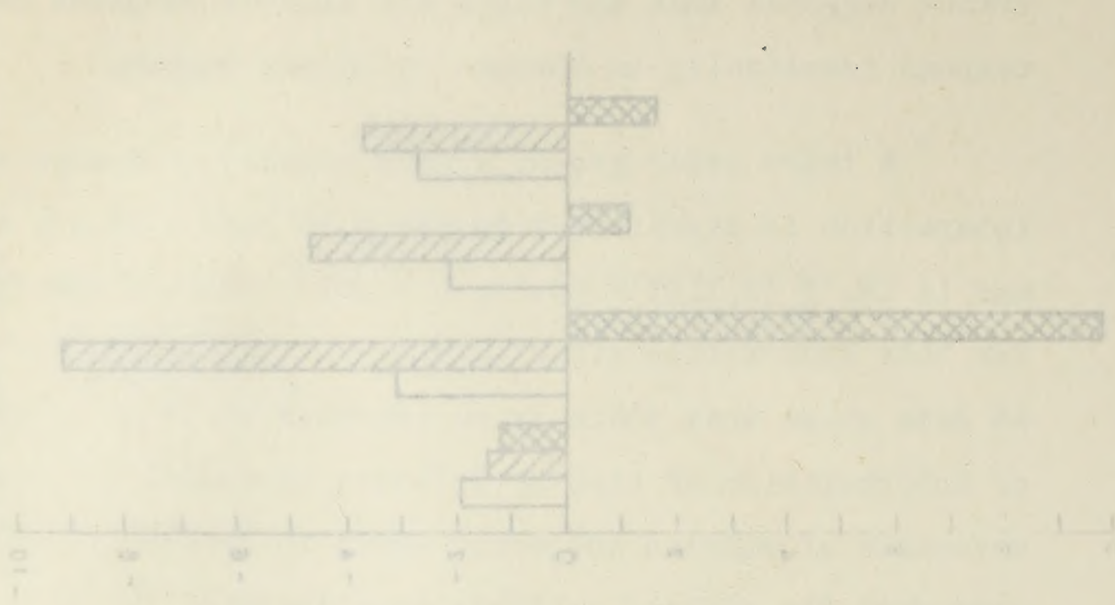
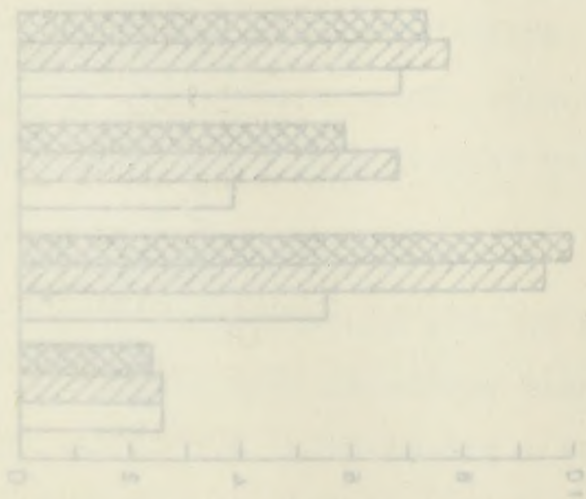


FIG. 3·9·8. SHOWING MEAN ABSOLUTE AND CONSTANT ERRORS OF SIGHTED AND BLIND GROUPS IN REPRODUCTION OF PRESELECTED AND CONSTRAINED CURVILINEAR MOVEMENT UNDER DIFFERENT RESPONSE BIASING CONDITIONS





3.289 and constrained movements but this is not so with the sighted subjects. The latter group is influenced by biasing activity only in recall of constrained movements. In other words, preselection is used effectively only by the sighted group such that even biasing effects are attenuated. In recalling constrained movement the sighted subjects are more affected by the biasing activities than the blind subjects who are much more experienced in the use of kinesthetic modality.

SUMMARY

This is about how psychologists and scientists of a couple of related disciplines have approached towards the construction of a science of human motor behaviour. It would not undermine the contribution of this approach if it is held that, knowingly or unknowingly, it has centered around the motor behaviour of only a privileged class of human being who have enjoyed the world through sight.

Though it has not got its due importance, a couple of these researchers have started wondering about the motor behaviour of those who have never seen the world because the movement without direct visual feedback causes severe inconveniences, e.g. limiting the richness of experiences of surrounding, ability to get about or modality, and control of environment and self in relation to environment. Therefore, the research reported in this chapter aims to

3.290 extend motor behaviour research to the world of sightless in order to build up a more comprehensive science of human motor behaviour.

In the scientific study of motor behaviour, it has been defined as a discrete graded movement which is basically initiated and controlled by an effector response. Depending upon the changes occurred as a result of movement, it has been categorized as location or distance movement. A location movement involves learning of location information in isolation of distance whereas a distance movement would involve learning of distance information irrespective of location. To be more specific, in a location task the subject has to reproduce the end point of a criterion movement (location) from a changed starting point; while he has to reproduce the total extent of movement (distance) from a changed starting point for a 'distance' task. In a situation, where location and distance information remain clubbed together, these are referred as simple movements. Movement has also been classified in terms of the administration of criterion target. The subject-defined movements are called 'preselected' whereas experimenter-defined movements are called 'constrained'. Based on these definitions a variety of movements can be made, viz. preselected simple movement, constrained simple movements, preselected location, constrained location, preselected distance and constrained distance. In terms of movement in various distractions in space movements are classified as

3.291 horizontal, vertical and curvilinear. To study the memory of linear movements (horizontal/vertical), a linear slide mounted with near frictionlessly moving slide and stop pegs is commonly used. For the study of memory of curvilinear movements a D-shape apparatus with basic operations essentially of the linear slide are used.

Congenitally blind and matching blindfolded sighted subjects were compared for their memory of a variety of abovesaid movements. For this, the subjects had to learn a movement and reproduce the same after brief delays.

The reproduction was examined not only in relation to recall delays but also in relation to a variety of activities surrounding the criterion movement. Three such activities have been employed. (a) prior activities are those tasks that involved learning of experiments (varying in numbers) before the learning of criterion movement. Deleterious effect of these tasks has been referred to as proactive inhibition. (b) Interpolated tasks, on the other hand, are those tasks which are introduced between learning and reproduction of the criterion movement. In some of the cases the subjects asked to count backward by 3s (attention demanding or capacity interference), while in other cases the subjects have to remove their hand from the slide/lever and to make certain other movements which were to be or not to be learnt (structural interference). Deleterious effect of

3.292 these distractors is called retroactive inhibition.
(c) Response biasing is a special case of retroactive inhibition which refers to the overestimation or underestimation of criterion movement during reproduction of a movement as a result of estimation of the criterion and interpolated trace caused by learning of an interpolated movement of longer or shorter magnitude than the criterion.

Another variable of vital interest in retention of movements is the length of movement.

Reproduction error is the mismatch between the criterion and reproduction movement. This mismatch is expressed as absolute error (AE), variable error (VE) or constant error (CE). For a given experimental condition AE is mean of unsigned error score on different trials, CE is mean of signed error scores on different trials, and VE is standard deviation of the signed error scores on different trials.

First three experiments constitute the pilot study. The experiments were conducted for exploratory purpose. In Experiment 1, effect of target length and retention intervals was studied on simple horizontal and curvilinear movement reproduction of blind (n = 18) and sighted (n = 18) subjects. Experiment 3.2 consists of immediate reproduction horizontal, vertical, and curvilinear movements of blind (n = 10) and sighted (n = 10) subjects as a function of

3.293 information and target length. In Experiment 3.3, an attempt has been made to study the effect of information, retention interval, and target length on the reproduction of horizontal, vertical and curvilinear movements of blind (n = 10) and sighted (n = 10) subjects. The results of this preliminary investigation not only supported our hypotheses but also tempted us to examine some hitherto unresolved issues in the field of motor control in general and coding mechanism of the blind people in particular.

Final study consists of six broad experiments to study a variety of movement situations and several variables and to explore the coding and retention processes of movement in blind and sighted subjects. Experiment 3.4, the first in this series, consists of a study of reproduction of horizontal movement of blind (n = 80) and sighted (n = 80) subjects as a function of information, preselection, target length, and retention intervals. In Experiment 3.5 an attempt has made to study the effect of prior activities informations, retention intervals and target length on the reproduction of horizontal, vertical and curvilinear movements of the blind (n = 42) and the sighted (n = 92) subjects. Experiment 3.6 consists of a study of effects of informations, retention intervals, interpolated tasks, and target length on the reproduction of horizontal, vertical and curvilinear movement of the blind (n = 72) and the

3.294 sighted (n = 72) subjects. An attempt was made in Experiment 3.7 to examine the effect of preselection, target length, and distractors on the reproduction of simple horizontal and curvilinear movements of the blind (n = 72) and the sighted (n = 72) subjects. Experiment 3.8 was conducted to study the effect of biasing conditions and target lengths on the reproduction of simple horizontal and curvilinear movements of the blind (n = 14) and the sighted (n = 14) subjects. In the last Experiment an attempt was made to replicate some part of the previous experiment to examine specifically the effect of preselection along with other variable on the reproduction of simple, horizontal and curvilinear movements of blind (n = 60) and sighted (n = 60) subjects.

In all, 378 blind and 378 sighted male adults who were matched for their age, education and intelligence were extensively examined on the reproduction of their movements.

Difference in the performance of the blind and sighted groups has been the central issue of investigation in this research endeavour. It was found that this difference between groups was mainly due to informations (Experiments 3.2, 3.3, 3.4, 3.5 and 3.6), preselection (Experiments 3.4, 3.7, and 3.9), target length (Experiments 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 and 3.9), and direction of movement (Experiments 3.3, 3.5, 3.6, 3.7, 3.8 and 3.9). The results show that

3.295 visual reference is not equally required for the processing of various informations. In other words, on certain types of the movement tasks the blind subjects are better than their sighted counterparts. On others they are as good as the sighted, and on the remaining ones they are inferior to the sighted.

Findings of the researches reported herein strongly support more precise, coding of location information (Experiments 3.2, 3.3, 3.4, 3.5, 3.6) than distance which has been the general conclusion of previous researches also. Finding based on present research that blind people are equal to or better than sighted people in reproduction of location whereas the former shows clearly poor performance than the latter in reproduction of distance (Experiment 3.4), suggest that location information in kinesthetically codable and regular use of kinesthetic modality, as in case of blind people, improves performance, but visual imagery based on prior visual experience of space and one's own movement in space is necessary for the coding of distance or movement extent.

It has been shown in previous studies of sighted subjects that preselected movements are better reproduced than constrained movements. This is so in the experiments reported in this chapter also (Experiments 3.4, 3.7 and 3.9). However, this generalization is held only partially true for

3.296 the blind subjects studied herein. It has been found in a study of simple movement reproduction that performance of sighted subject was superior to the blind in preselected condition while the reverse was true for constrained condition. It suggests that blind subjects have failed to derive advantage from preselection. Moreover, in movement situations where location and distance information are isolated blind subjects show a poor use of preselection in coding of location and fail to do so in the coding of distance information (Experiment 3.4). Similarly, they also fail to derive advantage from it when prior movements or response biasing was introduced.

In general, inconsistency in recall response increases with increase in the length of target. This pattern of data observed for sighted is not consistent for the blind people. It has happened in several experiments reported herein (Experiments 3.5, 3.6) that the blind subjects show a marked depression in their AE and VE on a middle 20 cm target particularly in case of distance. However, their AE and VE increase for long 30 cm target. CE results indicate that the blind subjects show a stronger tendency to underestimate long targets and overestimate short targets than their sighted counterparts. In other words, blind subjects show a strong central tendency effect of 'range effect'. Moreover, a comparative analysis of the performance of blind

3.297 and sighted subjects on short and long targets show that the two groups have mainly differed on long targets. All these findings together suggest that short movements, which could be programmed, were retained equally well with both blind and sighted subjects.

Although loss in motor memory, among other factors, is also due to lapse of time, as has been shown in several previous investigations, in our study the most interesting finding related to the effect of recall delay is seen in an interaction effect of groups, information and retention intervals (Experiment 3.4). Decay of traces has been found minimal in reproduction of location in both the blind and sighted subjects, while in reproduction of distance information is lost with lapse of time. This rate of loss is faster for blind subjects than their sighted counterparts. Results pertaining to preselection suggest that sighted subject are able to maintain their traces of preselected movements over unfilled delays but this was not so far the constrained movements. The blind subjects, on the other hand, show decay of both preselected and constrained movements at almost the same rate.

Most interesting result related to proactive inhibition emerges in Experiment 3.5, in a groups x informations x prior activities interaction effect. It suggests that prior visual experience has enabled sighted people to

3.298 attenuate the effects of proactive inhibition in distance reproduction but not in location reproduction. On the other hand, blind subjects showed proactive inhibition in both location and distance reproduction. A similar finding related to retroactive inhibition and preselection suggests that the sighted subjects showed hardly any effect of retroactive interference in preselected, but not constrained, movements while the blind subjects showed its effect in both preselected and constrained conditions (Experiment 3.7). Confirmation of these results was once more available in response biasing effects which were attenuated by the sighted group in preselected condition but not by the blind group.

Horizontal, vertical and curvilinear movements differ in their spatiotemporal nature. Owing to this reason differences between the blind and sighted groups were noted e.g. Experiment 3.3. Moreover, vertical task differ from the horizontal task because in the former the lever mass is to be lifted against gravity. Moreover, the spatial lay out is not identically represented in the two groups, e.g. blind people do not have a concept of verticality. They also hesitate to operate beyond their head level.

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CHAPTER 4

TOUCH AND BLINDNESS

NEURAL MECHANISMS OF TOUCH

There are four kinds of touch receptors, viz., free nerve endings, Meissner's corpuscles, pacinian corpuscles, and free nurve endings at the base of each hair. These are embedded in connective tissue in the dermal layer of the skin. The hair nerve ending is stimulated by change in position of the hair producing a brief burst of impulses followed by rapid adaptation. Meissner's and paccinial corpuscles also adapt rapidly. These can sense a quick touch but not a sustained touch. Free nerve endings slowly adapt to continuous stimulation. There are located in the superficial and the deep layers of the skin.

Pressure sensation differs from touch sensation in that the former is enduring. We can discriminate between a light pressure of a fingure on the arm and a hard pressure from the same source.

Informations from the touch receptors passes on to spinal cord along axons electrically, and across synapses

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Pressure sensation differs from touch sensation in that the former is enduring. We can discriminate between a light pressure of a figure on the arm and a hard pressure from the same source.

Information from the touch receptors passes on to spinal cord along axons electrically, and across synapses

4.2 chemically. In the spinal cord touch impulses run in the ventral spinothalamic tract which terminates in the posteroventral nucleus of thalamus. Touch impulses are relayed to postcentral gyrus in parietal lobe of cortex for interpretation of the incoming sensory message.

BEHAVIOURAL APPROACH TO THE STUDY OF TOUCH

Behavioural scientists like psychologists have attempted to understand the processing of touch information by examining the perceptual, learning, and reproduction responses of the subjects. In the current literature there has been disagreement in the results reported on these issues related to touch. It seems that this is mainly due to different terms employed interchangeably for a variety of touch responses. To begin with, it is essential that the conceptual meaning of these variety of touch responses should be clarified.

The Concept of Touch

The sense of touch was dichotomized as active and passive as early as in the beginning of nineteenth century (Major, 1898). Recently, Gibson (1962) emphasized on this dichotomy in the study of touch. He defined active touch as a mode of touching, contacting and exploring with the hand in which the skin, the joints, and the muscles function together in obtaining informations. There are a number of

4.3 concepts used synonymously for active touch, e.g., haptic sense (Kennedy, 1978; Millar, 1972; Revesz, 1950), tactile (Gibson, 1962; Hampshire, 1975) tactual (Miller, 1977; Warm and Foulke, 1968), and tactile-spatial (Hermelin and O'Connor, 1975 b). Passive touch, on the other hand, has been defined as one in which skin acts alone and gives punctuate sensation (touch marked with points or dots) localized in the skin. Synonymously used concepts for passive touch are cutaneous sense (Gault et al, 1936; Geldard, 1953; Gibson, 1962), tactile (Atteneave and Benson, 1969; Bliss, 1966; Gilson and Braddeley, 1969; Hermelin and O'Connor, 1971) and kinesthesis (Birch and Leeford, 1963). It is felt that one should be cautious enough in interpreting and comparing the results reported in the current literature. However, to obtain clarity in the review of the current literature herein it is decided to use the original concepts, viz., active and passive touch, rather than using the varients.

Some authors have elaborately dealt with the differences between active and passive touch. A summary of these are attempted, focusing on the behavioural and physiological differences between the two forms of touch. According to Gibson (1962), active touch is vastly different from passive touch. In the former, manipulations are made by the hands of the perceiver himself while in the latter, the stimulus is given by an outside agency. Hence, the

4.4 term active and passive are used. Manipulation by the perceiver is necessarily exploratory depending upon the movement that the subject makes while touching a particular object. This may be compared to the function of the eye and termed as 'tactile scanning'. On the other hand, passive touch is merely a receptive channel studied by sensory physiologists. This should be treated as a part of cutaneous sensitivity, emphasizing on temperature and pain as well.

When the hand is feeling an object every movement involves excitation of receptors of each joint right from the phalanx (bone) of each finger to those of the shoulder, including the back bone making its contribution. The total effect is enormously complex but meaningful combinations are made. Thus, touch involves inputs which come from skeleto-muscular system involving a large portion of the body. Hence, it is questionable whether this is a singular sense or a combination of many, as there is no single sense analogous to the ear or the eye which fulfills the criteria of a classical sense modality of touch. Nevertheless, the hand is quite a definite channel of external touch information, differing from other sense organs and requires investigation. If a description is made of the various stages involved in feeling an object, it may be observed that initially the subject manipulates by curling his fingers around the object. This is done in various complex ways such as

4.5 tracing movements with one or many finger-tips, rubbing, pressing and grasping of fingers. The other hand is also used, if permitted. Finally, an attempt is made to familiarize the object or name it, if possible. Once the object is recognised or categorised as familiar, further explorations stop. Thus, though movements are complex and varied, they definitely are not meaningless and in this sense, if the hand is conceived as a sense organ, the subject is consistently adjusting it to receive information. Active touch, therefore, searches for stimulus information in the absence of vision.

Commonly, psychologists assume that active touch is simply a blend of two modes of sensation - touch and kinesthesis - which merely means that the data from the feeling of movement are combined with that of feeling of contact, the two senses being fused as one experience. This, according to Gibson (1962), is not all. Active touch has more than what is described, namely, such a definition fails to take into account the purposive character of touching. It does not also emphasise the multiplicity of kinesthetic information that is involved.

According to Gordon (1978), analysis of tactile activities can be considered in two distinct phases, that of active and of passive, though in practice one pursues the other very rapidly such that the entire activity appears

4.6 to constitute a single, smooth, coordinated and uninterrupted purposeful act. The initial contact is one of a momentary, gentle touch which is one type of passive touch. The next phase is that of an actual finger manipulation of the object, simultaneously judging its weight, shape and other features. The position of the hand changes depending on the object of manipulation such that when the object is small or light, the palm faces downward, and is turned upward if the object is large or heavy. Usually more than one finger is involved in forward and backward rolling between the fingers and the palm. These processes also assess the distance of the object from the body, its centre of gravity, etc. If objects are many or are large in size then both hands are used. During these fine movements, the very stiffness creates vibratory effects which in all probability are detected by the deeply placed pacinian corpuscles. Nervous signals are sent for recognition with those of previously stored tactile patterns. The role of Meissner corpuscles in tactile discrimination is also noted when quick assessments are made. The varied presence of nerve endings in the different layers make it difficult to state the exact functions and participation during the two phases, active and passive. The micro mechanical structures of the skin are not yet explored satisfactorily and future research on skin senses necessarily need to study these aspects.

4.7 Role of Left/Right Hemispheres in the Processing of Touch

A psychoneurological approach to the study of information processing has distinguished the capabilities of the left and right hemispheres in the handling of various informations, viz. spatial patterns and language reasoning. Milner and Taylor (1972) used a tactile memory task in studying patients in whom the commissure linking the two cerebral hemispheres were cut. Patients matched irregular wire patterns either immediately or after delays. When the task was performed by the left hand (and hence the right cerebral hemisphere) most patients did the tests well even after considerable delay, while using the right hand, much poorer responses were obtained even for immediate tasks. This suggests that tactual and spatial tasks depend heavily on right hemisphere, a point which was earlier elaborated in connection with Braille reading. Kumar (1977), and Kumar and Sperry (1971), have also suggested that memory of the right hemisphere was superior to that of left hemisphere in a non-verbal concept formation study. Other evidences show that left hemisphere is dominant for sequential processing (Cohen, 1973; Fontenot and Benton, 1972; Helperim, Nachshol and Carmon, 1973) and that the right hemisphere is dominant in the processing of spatial patterns (Dimond and Beaumont, 1974; Kimura and Vanderwolf, 1976; Roy and Mackenzie, 1978).

4.8 An Information Processing Model of Memory:Touch.

Chapter 2 has already focussed on the information processing approach to the study of behaviour which includes discussion of the processing of information at sensory, short term and long term level (Atkinson and Shiffrin, 1968; Brown, 1958; Peterson and Peterson, 1959). However, these studies focussed mainly on the processing of visual or verbal informations.

Soon after this approach became more divergent with its application to the processing of a variety of nonverbal information, for example, touch, kinesthesis, etc. To investigate whether a similar processing system exists for both verbal and nonverbal informations, Bliss et al (1966) carried out extensive research on the processing of touch. Fig. 4.0.1 shows the specific model used by them as a framework for their analysis.

When a tactile stimulus is received, a filtered image of this pattern enters the sensory register where it begins to decay at a very fast rate. A limited amount of information is, however, processed and transferred to the short term store. It is possible to store this information without rehearsal for a few tens of seconds and with rehearsal, for indefinite periods of time.

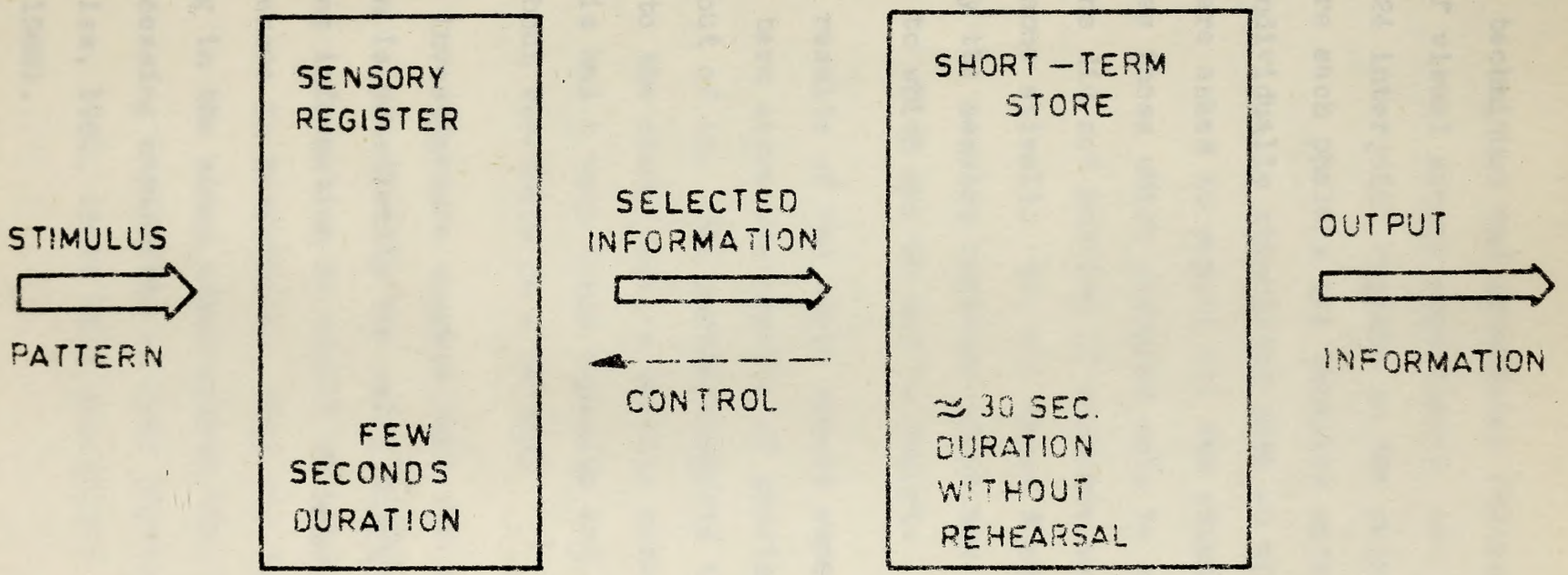


FIG. 4.0-1 FRAMEWORK FOR THE MEMORY SYSTEM MODEL (BLISS et al. 1966)

STIMULUS PATTERN
SENSORY REGISTER
NEW SECONDS DURATION
CONTROL
SELECTED INFORMATION
SHORT-TERM STORE
USE TO SEEK ADDITIONAL INFORMATION
OUTPUT

4.9 The techniques and procedures followed were similar to those of visual memory experiments, the tactile space being the 24 interjoint regions on the palm side of both hands. Here each phalanx was labelled with a letter and could be individually stimulated with an air jet. The subjects were asked to report all the stimulus positions, or sometimes those which occurred only in certain regions. Instructions did not mention if response was to be obtained to all or some stimuli. So, all those N stimuli would be recorded by the sensory register since the subject was unaware as to which one he had to report.

The results of the whole report experiments indicated that short term store was capable of storing 4 stimulus positions out of 12. The partial-reports indicated that analogous to the visual one, a tactile sensory register did exist. This had a very large capacity and an information decay of about two-third in a second.

The investigators suggest that the processing of information is practically the same, independent of whether the incoming information is visual or tactile. If there are differences in performance, they are due to the lack of training in the sense organ rather than any inferiority of the processing capability of that particular sensory system (Bliss, 1961, 1967; Hill and Bliss, 1968; Foulke and Warm, 1968).

.10 The kinesthetic and tactile senses offer many potential information channels. This is so because they respond to a wide range of stimuli, besides being rarely 'busy'. Further, even though these senses are the primary sources of information channels for the visually handicapped in reading and mobility, very few attempts have been made to study them directly with other information displays.

However, a majority of researchers have mainly focussed on short term recall of touch. In their studies they mainly attempted to examine the nature of coding and storage over short recall periods. To examine the nature of coding they adopted a variety of procedures, viz., intermodal and crossmodal transfer (Millar, 1972), feedback augmentation (Millar, 1971) and modality specificity of coding or structural versus capacity interference (Miller, 1974). In case of transfer studies information was presented through one modality and the recall was taken using the same modality (intramodal transfer) or different modality (intermodal or crossmodal transfer). Feedback augmentation was examined by presenting the touch information through only touch modality or through other modalities added together with touch. To examine structural interference an interpolated activity which occupied the same modality as that of the criterion information

4.11 (modality specific interference), or the other modalities mainly occupying central processing capacity (capacity interference) was used. However, all of the above said approaches aimed at examining whether information is coded in its specific modality, of transfer or integration of various modalities is possible.

Another controvercial issue which was considered critical in the processing of touch is the relative role of trace decay with time lapse (Gilson and Baddeley, 1969), and structural or capacity interference from the activities surrounding the criterion learning (Millar, 1974; Sullivan and Turvey, 1972) as the major determinants of forgetting of tones information.

PROCESSING OF TOUCH WITHOUT VISION

A detailed review of the literature related to the effect of blindness on perceptual development of blind people has already been given in Chapter 1. Hermelin and O'Connor (1975 b), and Millar (1974, 1976) employed a variety of tactual memory tasks but they could not reach to any specific conclusion regarding the effect of blindness on coding process. They further stated that the available data was not sufficient to make generalizations. More specific details of these studies will be given at relevant places in the following sections. However, more

4.12 specific attempts are needed to study the processing of touch information in blind as it makes a vital source of information for their total development.

In the following sections an attempt has been made to review the studies on the processing and storage of active touch information in detail. Section I mainly deals with the study of effect of delay and interference in memory of touch of blind and sighted subjects. Further in Section II coding and memory has been examined using a bimodal presentation procedure. A major objective of this section is to study the integration between touch and kinesthesis in blind and sighted subjects.

SECTION I

DECAY AND INTERFERENCE AS DESTRUCTIVE PROCESSES IN MEMORY OF TOUCH: SOME REFLECTIONS ON CODING MECHANISM

Studies on short term retention of touch have involved both active and passive touch. A major objective of these studies was to examine the coding mechanisms of touch informations by employing relevant structural and capacity interference tasks. Review of studies on this issue is divided as follows.

SECTION I

DECAY AND INTERFERENCE AS DESTRUCTIVE PROCESSES IN MEMORY OF TOUCH: SOME REFLECTIONS ON CODING MECHANISMS

4.13 Passive Touch.

Decay and interfering activities in tactile (passive) memory were examined by Gilson and Baddeley (1969) and their explanation is of considerable theoretical importance. These investigators stimulated a point on a subjects' forearm and demanded recall of the locus of stimuli after varied delay periods. The arm was touched lightly using a medium point ball-point pen and recall had to be given by pointing to the location of the touch by the finger. Between the stimulus and the response, the delay period was either unfilled or verbal. It was found that for the first 10 seconds performance did not differ in rest and activity conditions, but between 10-15 seconds a significant increase in error was found in the activity condition and the difference between activity and rest condition was also observed at delayed recall intervals. A point of interest here is that even when there was no interpolated task, recall accuracy of subjects further deteriorated with increase in recall delay. This led the investigators to suggest a memory mechanism possibly involving two separate processes: one a fading trace unaffected by distractors, and another which is affected by distractors and, hence, is dependent on rehearsal.

Sullivan and Turvey (1972) replicated this study and found no significant interaction between delay and interval

4.14 activities. They concluded that loss of information was not due to prevention of rehearsal but due to changes in the cognitive set.

Spatial-tactile (passive touch) parameters were investigated by Atteneave and Benson (1969). He employed 6 touch vibrators. Half of these were mounted on the horizontal side of a 'T' shape tube, whereas the other half were mounted on the vertical side. Horizontally and vertically placed vibrators were designated by six different letters of English alphabet. The subjects were asked to keep 3 middle fingers of one hand on horizontal vibrators and 3 middle fingers of the other hand on the vertical vibrators. Their task was to learn to associate these letters with the vibrators, and to report the letter name of the vibrated figure. Whether the responses should be given to refer to stimulation of a particular finger association was carefully left unspecified. Half of the subjects in the group began with right hand on the horizontal bar and left hand on the vertical while for the rest half the hand position was reverse. After 12 learning trials, the subjects were requested to exchange the positions of their left and right hands and were asked to respond the letters they had learnt either to the same fingers or to the same buzzers (vibrators). Two transfer trials were given on this basis without feedback. They were asked which of the two transfer response conditions (letters to

4.15 fingers or letters to vibrators) be thought would have been easier and why. Their responses showed that both types of associations were learned and transferred easily. Most interesting findings was that for subjects with unrestricted vision, association with vibrators were clearly stronger than finger associations. Such a finding gave evidence of spatial location as primarily being presented in visual turns even if input was derived from another sense modality. This brings one to notice that different material as handled and processed differently depending upon its encoding processes.

Somewhat similar work by Hermelin and O'Connor (1971) emphasized external location responses as being predominant in sighted subjects, while blind subjects mainly relied on their finger responses. This opened another dimension of analysis which projected on a difference between the representation of space with and without vision. The coding procedures were altered with the presence or absence of a sense modality.

Active Touch.

Retention of active touch has also been studied by several researchers. Hermelin and O'Connor (1975 b) used shape rotation task and hand orientation task to compare blind and sighted subjects. It was found that in the shape

4.16 rotation task both groups performed equally well. A visually based inference system, which the sighted are capable of utilizing, did not facilitate the performance of sighted subjects. However, in the hand orientation task sighted subjects were able to take advantage of visual schema showing better recall than the blind.

Modality effects in tactile (active) memory were tested by Millar (1974). This study investigated blind and sighted children using three dimensional nonsense shape. The standard stimulus was presented on the left tray and the comparison stimulus on the right tray. Responses were obtained by lifting the comparison shape and giving a 'yes' or 'no' to indicate their answer. The stimulus was presented for two seconds followed by appropriate delays (0, 5, 10, 30 sec). At the end of each delay, response was demanded. Interval activities consisted of unfilled delay, rehearsal, verbal distractor, and movement distractor. Movement distractors were found ineffective and, hence, showed no modality specific effect. Only a difference between interpolated and non-interpolated delay intervals was found. Rehearsal had no facilitation effect over unfilled delay interval. A striking finding of this study was that the blind subjects performed faster than the sighted group who in turn were more accurate than their blind counterparts. This was termed as speed-accuracy trade-off. Based on his results, Millar concluded that tactual memory may be

4.17 considered as 'after glow' or 'blurred vision'. However, she further added that it was unnecessary to assume that there are numerous distinct modality specific short term stores, each having distinct retention properties.

An interesting explanation by Goodnow (1971) suggests that the superiority of a modality depends upon the experience of working in that modality. She found that delayed recall produced deterioration in performance of sighted people but did not affect performance of blind subjects. This was found in a tactual task suggesting that modalities serve as sampling procedures and that modality superiority is determined by the extent to which it samples the salient and crucial informations. Similarly, others have also found that the ability to encode and organize material in a particular modality, becomes automatic, efficient and habitual with increase in age (Calfee, 1970; Kool and Agarwal, 1980).

Several popular hypothesis about intersensory relations have been putforth by Kennedy (1978):

1. Any form of intersensory transfer causes some loss of information as compared to intrasensory transfer (Conolley and Jones, 1970).

2. Storing of haptic information in memory has been found to be less efficient than storing it in visual memory (Millar, 1971).

4.18 3. Absolute features are difficult to compare crossmodally, while relational features are relatively easy (Bryant, 1974).

Millar (1971) contended that vision is most dominant modality to help memorization in younger children. Moreover, instructions to visualize the shape caused significant improvement in retention performance of sighted children (Millar, 1972).

Birch and Leeford (1963) in an extensive study tested children from 5 to 11 years of age. They utilized 3 crossmodality interactions, a visual-haptic, a visual-kinesthetic and a haptic-kinesthetic task. The term kinesthetic meant passive tactual experience while haptic meant active explorations by touch. Eight shapes from the 'Seguin Form Board' were utilized, each of which were compared with the rest of all the three conditions. 'Same' or 'different' responses of the subjects were recorded. A total number of 145 subjects participated with approximately 20 subjects for each of the age groups of 5, 6, 7, 8, 8, 10 and 11 years. Results show a marked decline in errors with age which were analysed in terms of equivalence and non-equivalence responses. But these findings are not very clear regarding development of cross-modal transfer, between the age group of 5-11 years

4.19-25

except for comparison of identical forms. Suggestions given by Gibson (1969) regarding developmental studies of modality transfer, states that abstract non-modal properties as that of 'Roughness' or 'Straightness' are transferred and hence improvement with age may be due to the increasing awareness of transformations that underlie both intermodal and intramodal perceptual development. At this instance it might be useful to study further higher age groups where such transfers could become more efficient.

EXPERIMENT 4.1

The first experiment focusses on the coding mechanisms involved in tactual memory of blind and sighted people. Review of current literature regarding the efficiency in performance of the blind subjects in perception of tactual shapes yields an inconsistent picture. While some studies indicate similar performance by the two groups (Worchel, 1951; Evart and Carp, 1963), others have shown a difference, with the blind subjects showing superior performance (Plata, 1942; Foulke and Warm, 1967; Pick and Pick, 1966). Few studies have also reported poorer performance by the blind subjects in certain cases (Axelrod, 1959; Gomulki, 1966) on tactual form perception. Further, a study testing retention of spatial parameters has not been able to project a clear difference between sighted and blind subjects (O'Connor and Hermelin, 1975). Numerous questions on tactile retention processes were raised by Millar (1974) regarding differences between sighted and blind subjects. These were mainly concerning modality-specific coding in tactual memory as also the effect of attention-demanding distractors on children.

In a later study (1977) she stated that the utilization of tactual and kinesthetic memory as an information channel becomes primary in the case of individuals handicapped with loss of vision. Given the

fact that sighted individuals predominantly are in the habit of relying on visual cues, the major problem raised here is whether a visual reference system affects retention of tactual information for the sighted people as against the blind individuals who rely on tactual and other non-visual informations alone.

Following a proposition put forth by Neisser (1967) that if coding of tactual information is modality specific, interpolation of a tactual task would cause interference and hamper the performance, while interpolation of tasks that occupy modality other than touch which show no interference and hence no decrement in performance. One of the earliest attempts made in this direction by Millar (1964) failed to establish that coding of tactual information is modality specific, though she considered her interpolated activity to be an inappropriate modality specific task (Millar, 1975). She further contended that blind children can encode tactual inputs either tactually or verbally, but that this is probably dependent on different processes. In the present experiment it is intended to explore further the issue of modality specificity of the coding of tactual information. So far, there have not been many clear cut efforts on this line.

It is also difficult to say how far sighted children visually recode tactile shape information. Millar (1974) stated that tactual retention tested under distractors show recoding capacities clearly. One possibility is that visual or verbal distractors would show more serious effects on the sighted, as compared to blind subjects. In the present study, an attempt has been made to examine this issue.

In a different article Millar (1976) had contended that age would not be a very significant variable. This position taken by her contradicts Piaget's contention (see Chapter 1 for details) that 'cognitive development is from the earliest sensory-motor coordination of infants in a series of stages related to age' (Reese and Lipsitt, 1973, p. 480). Since Millar's study (1974) had only children of lower age groups (5-7 years and 9-11 years), these results might not be valid for adults and if Piaget's developmental theory is to be rejected. Hence, the present study proposes to verify the effect of specific distractors of adult groups of the blind and sighted people.

Method and Procedure

Sample. In the present experiment a sample consisting of 32 adult subjects was used which included 16 blind and 16 sighted subjects between the age group of 18-35 years.

4.29

The criteria for selecting the blind subjects were: (a) Degree of blindness: total. (b) Age at onset of blindness: birth or very early during the first year of life. (c) Absence of other disabilities: no history of psychological, mental or any other physical disability.

They were selected from the various workshops and schools for the blind in Bombay city of Maharashtra. The sighted subjects were also selected from the same city who were matched in age, education and intelligence level with the blind subjects.

Apparatus and Materials. Twenty pairs of three dimensional non-sense shapes, as used by Millar (1974), were used (Fig. 4.1.1). The dimensions of the shapes were 2.5 x 2.5 x 1.3 cms. These differed in shape with respect to the number of turns, length of angles, straight versus curved lines, etc. These non-sense shapes were used to minimize the likelihood of any verbal coding and were made of transparent perspex. Equality in size was maintained to avoid differences in coding. Other materials included two trays for stimulus presentation, a pair of opaque goggles, and a reaction timer.

Experimental Design and Procedure. A 3 way 2 x 3 x 2 within subject design (Figure 4.1.2) having between block treatment of groups (sighted or blind) and within block

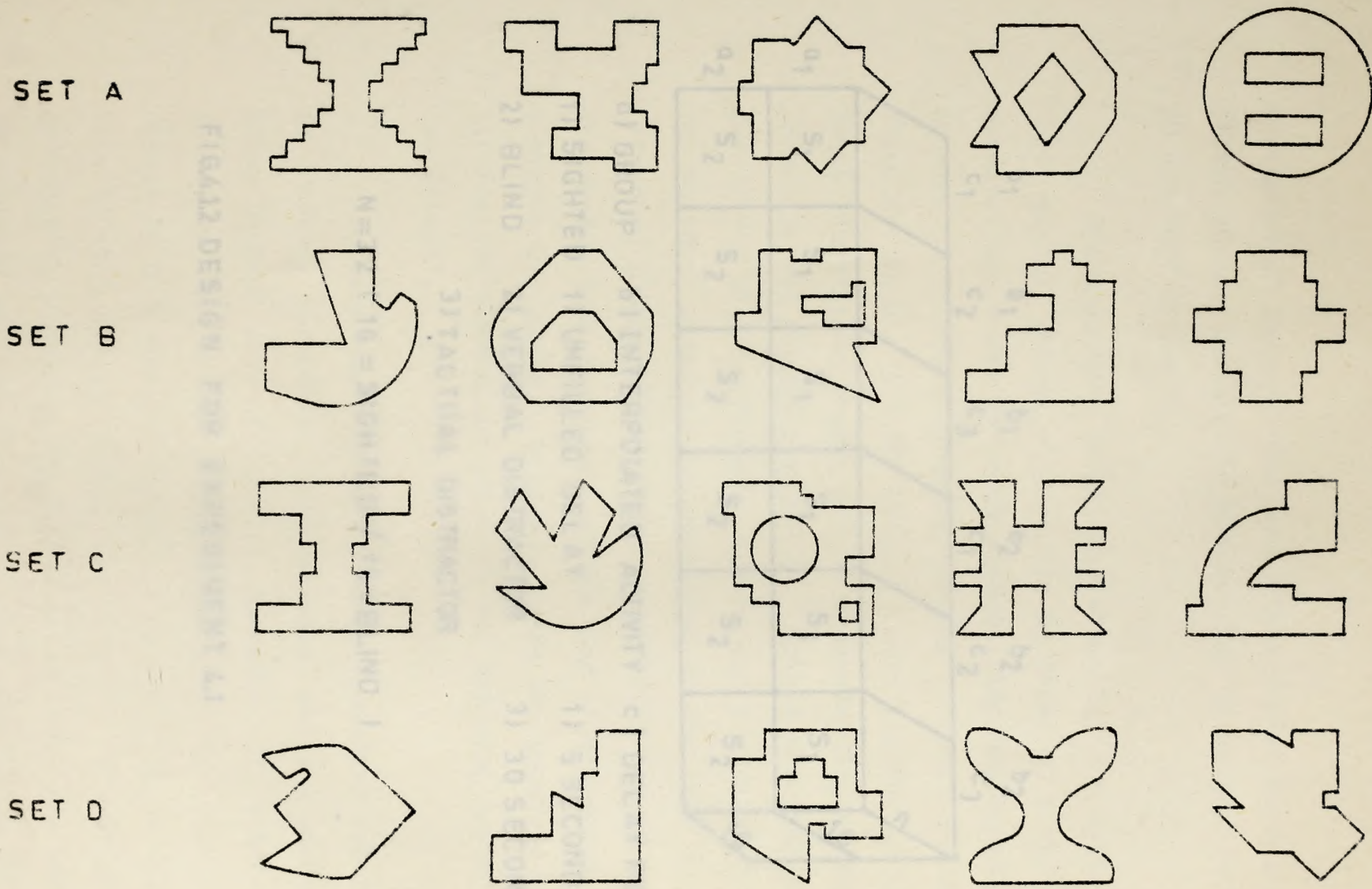


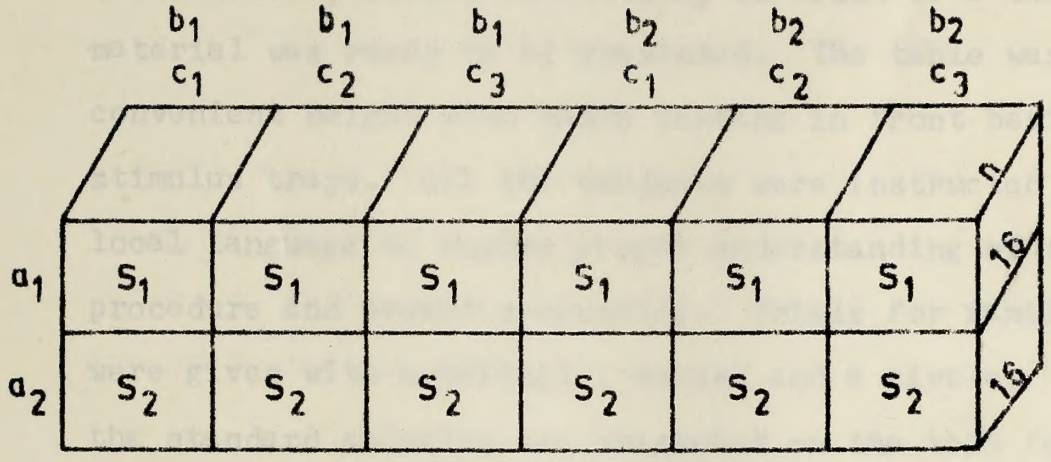
FIG.4.1.1 MATERIALS UTILIZED FOR EXPERIMENTS 1, 2 + 3

SET A

SET B

SET C

SET D



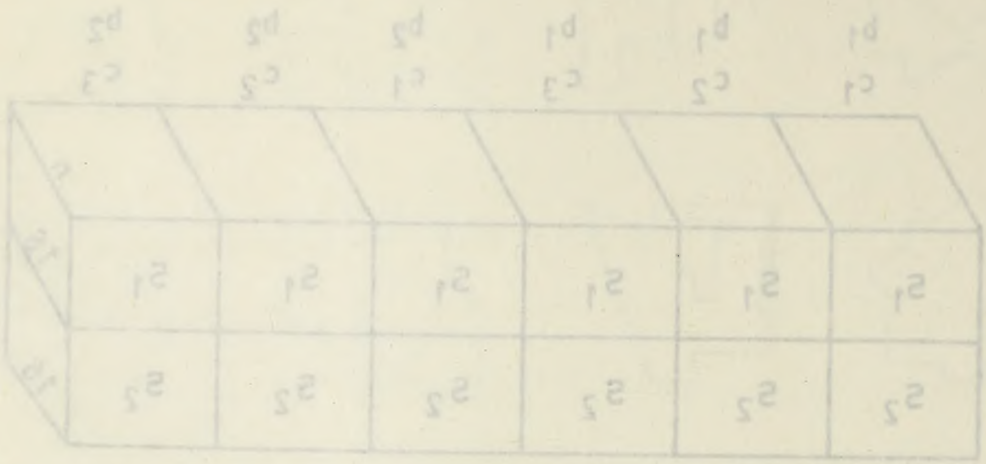
a) GROUP
1) SIGHTED
2) BLIND

b) INTERPOLATED ACTIVITY
1) UNFILLED DELAY
2) VERBAL DISTRACTOR
3) TACTUAL DISTRACTOR

c) DELAY PERIOD
1) 5 SECONDS
3) 30 SECONDS

N=32 (16 = SIGHTED / 16=BLIND)

FIG.4.1.2 DESIGN FOR EXPERIMENT 4.1



4.30

treatment of interpolated activities (unfilled delay, verbal distractor or tactual distractor) and delay intervals (5 or 30 seconds) was used.

Subjects were tested individually in a quite room of their school, seated comfortably in front of a table where material was ready to be presented. The table was of a convenient height with hands resting in front beside the stimulus trays. All the subjects were instructed in a local language to ensure proper understanding of the procedure and prompt responding. Trials for familiarization were given with a triangle, square and a circle. After the standard stimulus was presented on the left for 2 seconds (standard exposure), a period of unfilled delay, or distractor task followed. At the end of the delay period a signal was given to respond. This was obtained by lifting the comparison stimulus and replying 'same' or 'different'.

Between the withdrawal of the standard and the signal to compare, the interpolated material was introduced. The delay periods were of 5 and 30 seconds. All subjects were tested on each of the interpolated tasks for both these delays in a randomised manner. (a) Unfilled delay: Subjects were to wait for the signal to respond. Instructions did not specify anything for this time and subjects were free to rehearse the material mentally if they chose to.

(b) Verbal distractor: Subjects were asked to count backwards from a two digit number spoken by the experimenter on the withdrawal of the standard until the signal to respond. (c) Tactual distractor: This involved manipulation of similar material as that of the standard, during the entire delay interval.

Dependent Variables. Accuracy in terms of 'same' or 'different' responses was recorded for the correct answer. Latency was measured using electronic digital reaction timer, which could measure RT in thousandth of a second. Raw-scores obtained for each of the subjects in all conditions are presented in Appendix 4.I.

Results and Discussion

Table 4.1.1 shows the response latencies (means and S.D.) and errors obtained in this experiment. To ascertain the statistical significance of the difference of the means, two 3-way analysis of variance (ANOVA) tests were applied. The error rates being very low could not show any meaningful results. Due to the ceiling effect of recall accuracy these data were dropped from further analysis. Emphasis was, therefore, only placed on the response latencies which indicated certain clear differences. A similar approach has earlier been taken by Millar (1972), wherein she suggested that in such circumstances latency measures would provide appropriate information to clarify underlying processes in memory.

TABLE 4.1.1

MEAN LATENCY SCORES (IN SECONDS) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED ADULTS UNDER VARIOUS DISTRACTORS (D) AND RECALL INTERVALS (RI)

Distractors	Recall intervals (in seconds)	Sighted		Blind	
		Latency	Error	Latency	Error
Unfilled Delay	5	2.25 (0.70)	.13	2.64 (1.10)	.19
	30	3.35 (1.34)	.69	3.29 (1.28)	.63
Verbal Distractor	5	2.77 (1.70)	.69	2.20 (0.80)	.31
	30	2.65 (1,11)	.19	2.77 (1.04)	.38
Tactual Distractor	5	2.66 (1.00)	1.00	3.33 (1.73)	.94
	30	3.53 (1.67)	1.38	4.13 (1.70)	.63

TABLE 4.1.1

MEAN LATENCY SCORES (IN SECONDS) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED ADULTS UNDER VARIOUS DISTRACTORS (D) AND RECALL INTERVALS (RI)

Distractors	Recall intervals (in seconds)	Sighted Latency	Sighted Error	Blind Latency	Blind Error
Unfilled Delay	5	2.25 (0.70)	.13	2.64 (1.10)	.19
	30	3.88 (1.54)	.89	3.29 (1.58)	.83
Verbal Distractor	5	2.77 (1.70)	.69	2.20 (0.80)	.31
	30	2.68 (1.11)	.10	2.77 (1.04)	.38
Tactual Distractor	5	2.66 (1.00)	1.00	3.32 (1.73)	.94
	30	3.53 (1.67)	1.38	4.13 (1.70)	.63

TABLE 4.1.2

SUMMARY OF ANOVA OF EXPERIMENT 4.1

Source	Ss	df	Ms	F	P
Between subjects	180.02	31			
Groups (G)	2.36	1	2.36		
Ss.w.group	177.66	30	5.92		
Within Subjects	198.18	160	1.24		
Distractors (D)	24.58	2	12.41	12.41	.01
G x D	7.38	2	3.69	3.73	.05
D x Sub.w.groups	59.39	60	.99		
Recall Intervals (RI)	22.09	1	22.09	32.97	.01
G x RI	.15	1	.15	.23	
RI x Ss.w.groups	20.15	30	.67		
D x RI	7.37	2	3.69	3.88	.05
G x D x RI	.07	2	0.04	0.042	
D x RI x Ss.w.groups	57.00	60	.95		

TABLE 4.1.2

SUMMARY OF ANOVA OF EXPERIMENT 4.1

Source	Ss	df	Ms	F	P
Between subjects	180.02	31			
Groups (G)	2.36	1	2.36		
Ss.w.group	177.66	30	5.92		
Within subjects	108.18	160	1.24		
Distractors (D)	24.58	2	12.41	12.41	.01
G x D	7.33	2	3.69	3.72	.05
D x Sub.w.groups	59.39	60	.99		
Recall Intervals (RI)	22.09	1	22.09	32.27	.01
G x RI	.15	1	.15	.23	
RI x Ss.w.groups	20.15	30	.67		
D x RI	7.37	2	3.69	3.88	.05
G x D x RI	.07	2	0.04	0.042	
D x RI x Ss.w.groups	57.00	60	.95		

Results obtained from ANOVA for response latency are presented in Table 4.1.2. Main variable of groups does not show any significant differences. This proves that recall scores of the sighted and blind subjects do not differ to the same magnitude as those reported in an earlier investigation by Miller (1974). The difference between the results of the present experiments and those of Millar could be attributed to the difference in age groups and other sampling differences. However, the general trend of the data in the two experiments bears close resemblence.

Distractor as a main variable is highly significant, F (2,60) = 12.41, $p < .01$. Hence, independent of other factors, these distractors have shown clear differences, their mean latency values being 2.88, 2.60 and 3.46 sec for unfilled delay, verbal distractor and tactual distractor, respectively. Main effect of delay is also statistically significant, F (1,30) = 32.97, $p < .01$, the means for 5 and 30 sec delays being 2.64 and 3.32 sec, respectively.

An important finding here is a significant effect of first-order interaction of groups x distractors, F (2,60) = 3.73, $p < .05$. This finding shows that the two groups differ in the pattern of their response latencies under different distractor conditions. A cursery view of the mean table gives an indication of such a difference in their level of response. From Figure 4.1.3 showing mean

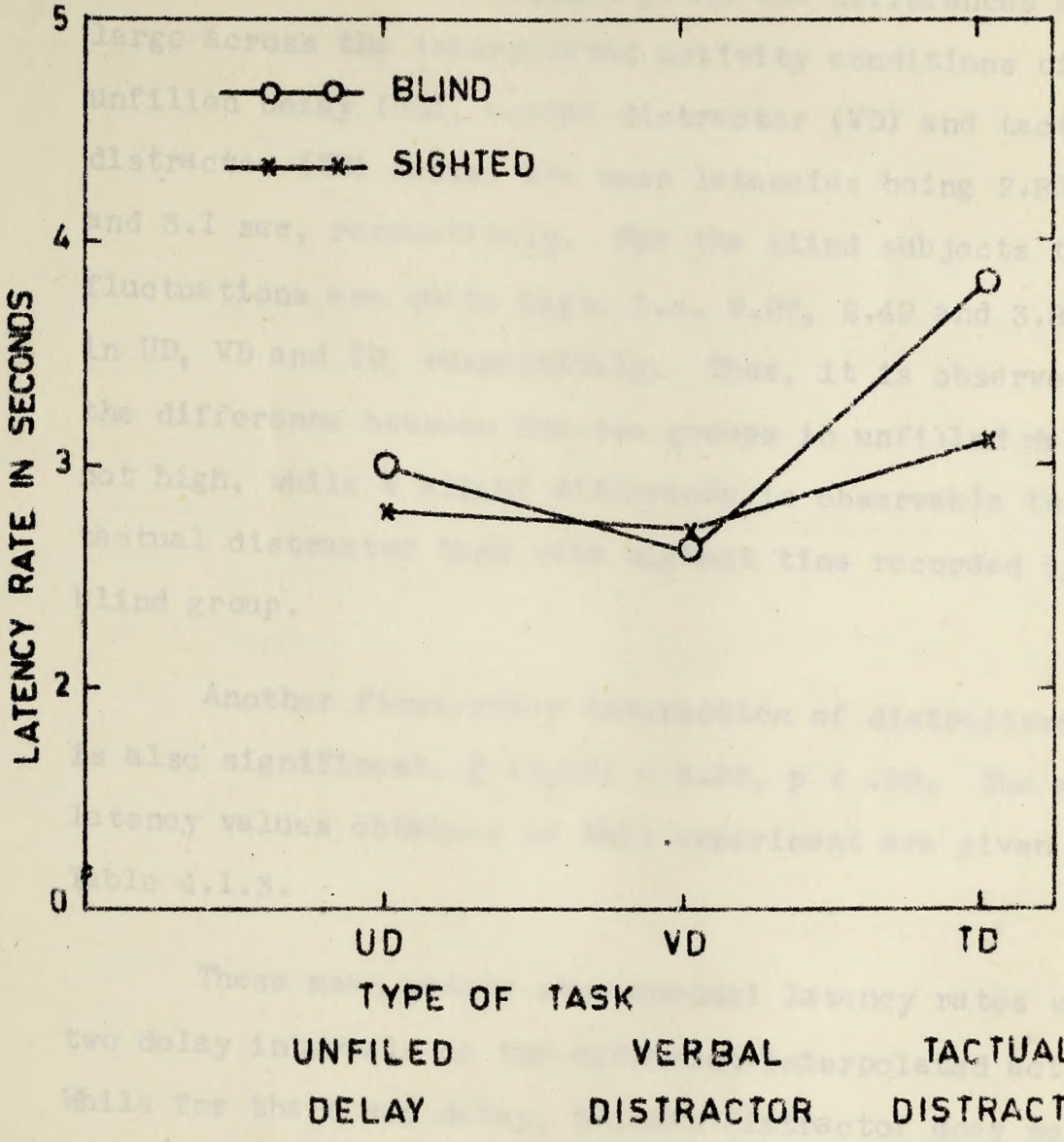
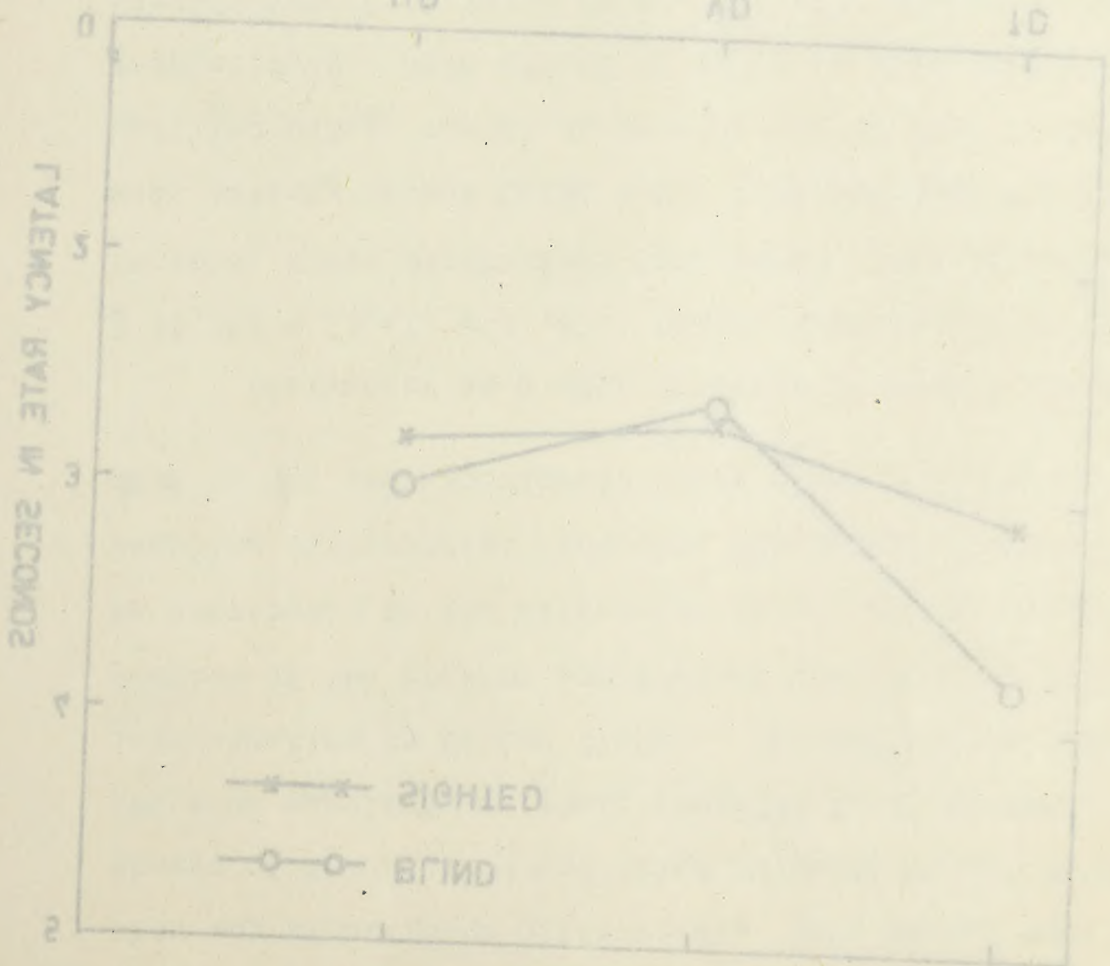


FIG.4.1.3 LATENCY RATE OF BLIND AND SIGHTED SUBJECTS ON VARIOUS DISTRACTORS


SIGHTED
BLIND

4.35

latency values obtained for this interaction, it may be observed that in the sighted group the differences are not large across the interpolated activity conditions of unfilled delay (UD), verbal distractor (VD) and tactual distractor (TD) tasks, the mean latencies being 2.80, 2.71 and 3.1 sec, respectively. For the blind subjects these fluctuations are quite high, i.e. 2.97, 2.49 and 3.80 sec, in UD, VD and TD, respectively. Thus, it is observed that the difference between the two groups in unfilled delay is not high, while a slight difference is observable in the tactual distractor task with highest time recorded by the blind group.

Another first-order interaction of distractors x RI is also significant, F (2,60) = 3.83, $p < .05$. The mean latency values obtained in this experiment are given in Table 4.1.3.

These mean values show unequal latency rates with the two delay intervals on the different interpolated activities. While for the 5 sec delay, tactual distractor does not yield significantly higher latency rates than verbal or unfilled delay task, in the 30 sec delay period verbal distractor produces fastest recall.

Although the blind and sighted groups do not show overall difference in their total recall performance, the

4.36

TABLE 4.1.3

MEAN LATENCY SCORES OBTAINED FOR THE DISTRACTORS AT 5 AND 30 SECOND RECALL INTERVALS

Distractors	5 sec	30 sec
Unfilled delay	2.45	3.32
Verbal	2.49	2.71
Tactual	2.99	3.92

difference between them in terms of coding processes are revealed when sensitive interpolated tasks are introduced. Both the groups show increase in recall time due to increase in delay, and support the results of earlier investigators (Gilson and Baddeley, 1969; Millar, 1974).

The most important finding of the present study has been the significant effect of groups x distractors. This indicates that response latency differs between the two groups when tested under verbal and tactual distractors. However, the present experiment utilized a within subject design due to which it could be anticipated that some of the data of this experiment might have been influenced by the exigencies of the experimental paradigm. Therefore, to highlight these differences another experiment consisting of a randomized block design was planned.

Another important variable considered in the next experiment was the factor of age. Certain differences that were obtained in the present experiment when compared to an earlier study by Millar (1974) could be attributed to this factor as her sample consisted of children of 9-11 years, while the sample under study here belonged to the category of adult population. It was, therefore, proposed that the two age groups should be directly compared in the next experiment.

EXPERIMENT 4.2

Experiments concerning the development of children show that integration of information from various sense modalities slowly develop with increase in age. Piaget (1952) is of the opinion that such integrations are inbuilt patterns of behaviour, while White and Held (1966) on the basis of their investigations emphasize on experience to be a more important factor. Early in life, according to them, sensory dominance of vision is quite clear which subsequently gives way to utilization and integration of information from other sense organs, e.g. co-ordinating eye-hand or eye-object behaviour. Similar view has been put forth by Birch and Leeford (1952) who state that cross-modal transfer is the result of learning in the developing child. These studies support the contention that with the development of age, the ability to extract features from any sensory store develops.

It may be recalled that no difference was observed with the introduction of distractors between the performance of sighted and blind children (Millar, 1974). However, in Experiment 4.1 the sighted and blind adults differed in terms of interpolated activities. It is, therefore, attempted in the present experiment to focus on age differences by directly comparing children of 9-11 years of age with an adult group of 18-25 years.

4.39

Reference to developmental studies (e.g. Fraiberg, 1968) in Chapter 1 made it clear that very early developmental trends of both blind and sighted children are similar but differences begin to appear in crawling or body displacements, as such behaviours lack incentives for moving without visual feedback. Gomulki (1961) made an extensive study of sighted and blind children between the age range of 5-15 years. He found that though performance was initially inferior in the blind group in comparison to the sighted, by 15 years of age blind subjects had surpassed the sighted in certain tasks. It is important to compare the blind people against the sighted ones in both the above mentioned age groups. The difference in the overall performance level of the blind and sighted children as against the sighted and blind adults would be brought to light. Further, differences are expected to emerge when interpolated activities focusing on the differences in coding processes are introduced. Delay effects were also examined in this experiment in relation to the distractors.

Method and Procedure

Sample. A total of 166 subjects were used with 96 adult subjects (48 sighted and 48 blind) in the age group of 18-25 years, and 72 children (42 sighted and 28 blind) within the age group of 9-11 years.

Reference to developmental studies (e.g. Freiberg, 1968) in Chapter I made it clear that very early developmental trends of both blind and sighted children are similar but differences begin to appear in crawling or body displacements, as such behaviours lack incentives for moving without visual feedback. Gomulki (1961) made an extensive study of sighted and blind children between the age range of 5-15 years. He found that though performance was initially inferior in the blind group in comparison to the sighted, by 15 years of age blind subjects had surpassed the sighted in certain tasks. It is important to compare the blind people against the sighted ones in both the above mentioned age groups. The difference in the overall performance level of the blind and sighted children as against the sighted and blind adults would be brought to light. Further, differences are expected to emerge when interpolated activities focusing on the differences in coding processes are introduced. Delay effects were also examined in this experiment in relation to the distractors.

Method and Procedure

Sample. A total of 160 subjects were used with 80 adult subjects (40 sighted and 40 blind) in the age group of 18-28 years, and 72 children (36 sighted and 36 blind) within the age group of 8-11 years.

Apparatus and Materials. These were identical to those reported in the previous experiment.

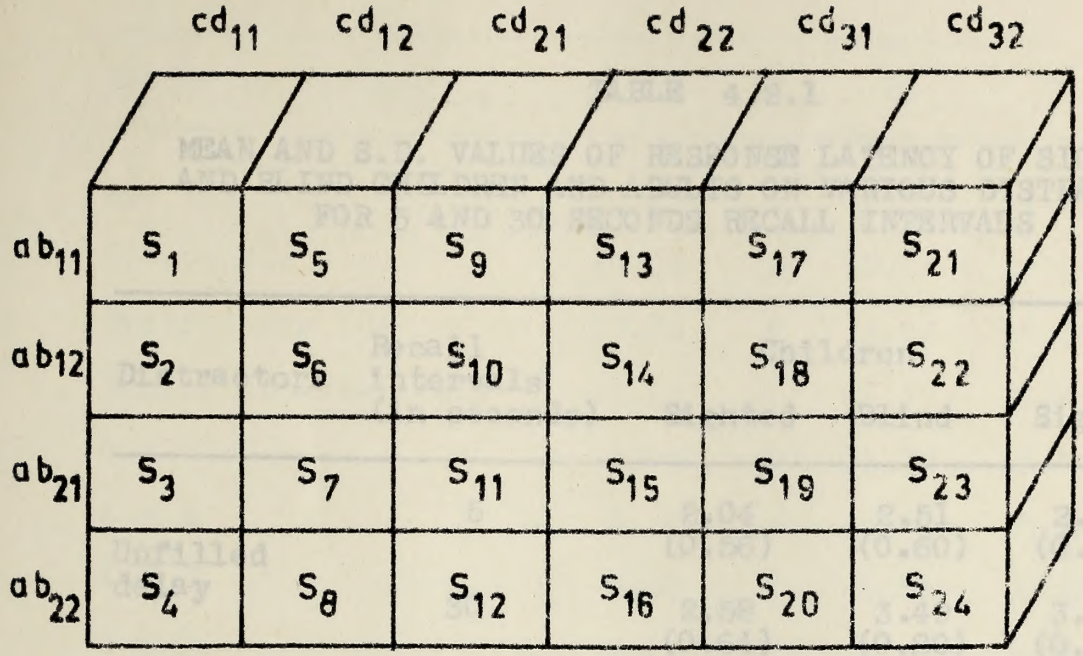
Experimental Design and Procedure. A 4-way 2 x 2 x 3 x 2 between subject (unequal cell) factorial design (Figure 4.2.1), with age (children or adults) x groups (sighted or blind) x interpolated activities (unfilled delay, verbal distractor or tactual distractor) and delay intervals (5 or 30 seconds) were utilized in this experiment.

In this factorial design the subjects were randomly assigned in roughly equal number to each one of the treatment levels. Hence only one type of task was given to one subject, with a total of 10 trials. This was completed in one session with an inter-trial interval of one minute each.

Dependent Variables. Responses were recorded in terms of response latency as done in the previous experiment. The raw scores obtained for each of the 166 subjects are presented in Appendix 4.II.

Results and Discussion

Response latencies (Means and S.D.) are presented in Table 4.2.1. The data were subjected to Analysis of Variance and Table 4.2.2 shows ANOVA results. Main effect of group is highly significant, F (1,23) = 19.83, $p < .01$,



a) GROUP
1) SIGHTED
2) BLIND

b) AGE LEVEL
1) CHILDREN (9-11 YRS)
2) ADULTS (18-25 YRS)

c) INTERPOLATED ACTIVITY
1) UNFILLED DELAY
2) VERBAL DISTRACTOR
3) TACTUAL DISTRACTOR

d) DELAY INTERVALS
1) 5 SECONDS
2) 30 SECONS

N=166 (90=SIGHTED/76BLINDS)

FIG4.2.1 DESIGN FOR EXPERIMENT 4.2

	cd_{11}	cd_{12}	cd_{21}	cd_{22}	cd_{31}	cd_{32}
ab_{11}	S_1	S_5	S_9	S_{13}	S_{17}	S_{21}
ab_{12}	S_2	S_6	S_{10}	S_{14}	S_{18}	S_{22}
ab_{21}	S_3	S_7	S_{11}	S_{15}	S_{19}	S_{23}
ab_{22}	S_4	S_8	S_{12}	S_{16}	S_{20}	S_{24}

a) GROUP b) AGE LEVEL c) INTERPOLATED ACTIVITY

1) SIGHTED 1) CHILDREN (8-11 YRS) 1) UNFILLED DELAY

2) BLIND 2) ADULTS (18-25 YRS) 2) VERBAL DISTRACTOR

3) TACTUAL DISTRACTOR

d) DELAY INTERVALS

1) 5 SECONDS

2) 30 SECONDS

N=166 (80=SIGHTED/70BLINDS)

FIG4.2.1 DESIGN FOR EXPERIMENT 4.2

TABLE 4.2.1

MEAN AND S.D. VALUES OF RESPONSE LATENCY OF SIGHTED AND BLIND CHILDREN AND ADULTS ON VARIOUS DISTRACTORS FOR 5 AND 30 SECONDS RECALL INTERVALS

Distractors	Recall intervals (in seconds)	Children		Adults	
		Sighted	Blind	Sighted	Blind
Unfilled delay	5	2.04 (0.56)	2.51 (0.60)	2.15 (0.35)	2.62 (0.39)
	30	2.58 (0.64)	3.49 (0.80)	3.00 (0.47)	3.09 (0.94)
Verbal distractor	5	2.05 (0.53)	2.22 (0.30)	2.83 (0.79)	1.94 (0.22)
	30	2.16 (0.52)	3.51 (0.67)	3.06 (0.63)	2.41 (0.44)
Tactual distractor	5	2.43 (0.39)	3.40 (1.10)	2.46 (0.96)	3.89 (1.11)
	30	2.82 (0.39)	3.80 (1.10)	3.10 (0.96)	3.93 (1.11)

4.42

TABLE 4.2.2

SUMMARY OF ANOVA FOR EXPERIMENT 4.2

Source of variance	Ss	Df	Ms	F	p
Age (A)	0.37	1	0.57	1.12	
Groups (G)	10.14	1	10.14	19.83	.00
Distractors (D)	13.85	2	6.93	13.55	.00
Recall Interval (RI)	11.17	1	11.17	21.84	.00
A x G	3.45	1	3.45	6.74	.01
A x D	0.22	2	0.11	0.22	
A x RI	0.28	1	0.28	0.56	
G x D	7.14	2	3.57	6.98	.00
G x RI	0.22	1	0.22	0.44	
D x RI	0.77	2	0.38	0.75	
A x G x D	4.75	2	2.38	4.65	.01
A x G x RI	1.50	1	1.50	2.93	.09
A x D x RI	0.16	2	0.08	0.16	
G x D x RI	1.67	2	0.83	1.63	
A x G x D x RI	0.05	2	0.02	.05	

showing difference in the response latency scores of blind (Mean = 3.06 seconds) and sighted (Mean = 2.56 seconds) subjects. Effect of distractors, F (2,23) = 13.55, $p < .00$, is also highly significant, the latency scores being 2.67 sec, 2.52 sec, and 3.24 sec, for unfilled delay, verbal distractor and tactual distractor, respectively. This pattern is consistent with the previous experiment. Effect of delay is also statistically significant, F (1,23) = 21.84, $p < .01$. Age as a main effect is not significant.

The first-order interaction effects reveal some interesting information. A first-order interaction effect of age x groups, F (1,23) = 6.74, $p < .01$, suggests that the visual reference plays a distinct role at the two age levels. The mean values obtained for this interaction are presented in Figure 4.2.2. It is clear from this figure that in the age range of 9-11 years the blind children have a higher latency scores than the sighted children (Blind = 3.14 sec and sighted = 2.34 sec). This is indicative of the fact that the blind children between 9-11 years of age are slower in responding even when tested in a familiar tactual mode, while their sighted counterparts are able to respond faster, although they were required to respond to a mode unfamiliar to them. Hence, lack of visual experience in very early period seems to cause poorer

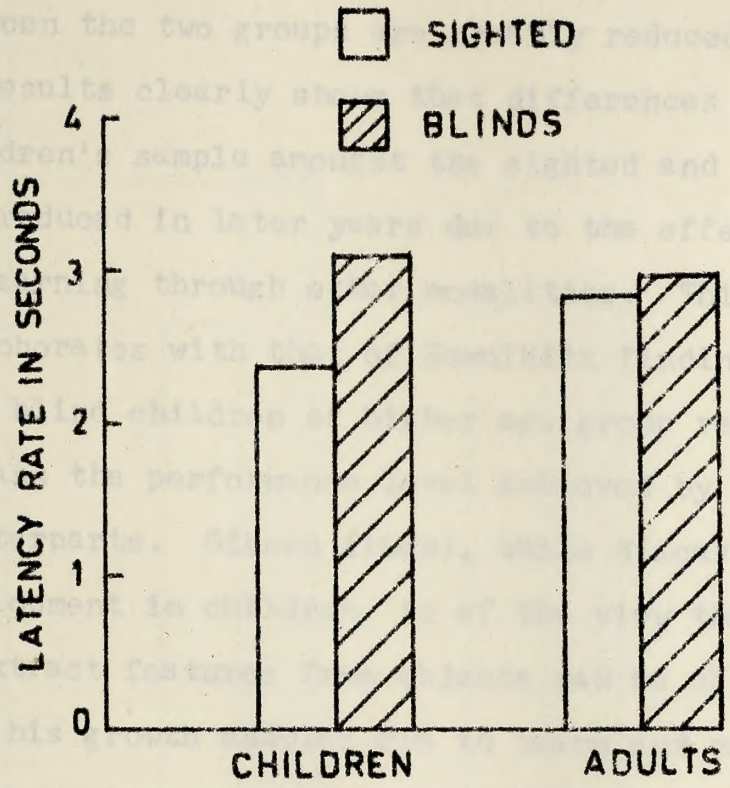


FIG.4.2.2 LATENCY RATE OF CHILDREN AND ADULTS OF BLIND AND SIGHTED SUBJECTS

FIG.4.2.2 LATENCY RATE OF CHILDREN AND ADULTS OF BLIND AND SIGHTED SUBJECTS

response, possibly because tactual coding is not developed enough so as to compensate for the deficiency by this age.

It is observed in the adult group that the differences between the two groups are greatly reduced. This trend in results clearly shows that differences obtained in the children's sample amongst the sighted and blind groups are reduced in later years due to the effect of development in learning through other modalities. This finding corroborates with that of Gomulki's finding which shows that blind children of higher age group recover and may surpass the performance level achieved by their sighted counterparts. Gibson (1969), while discussing memory development in children, is of the view that the ability to extract features from objects can be observed such that his growth enables him to learn and retain features of any sensory modality. The above mentioned finding of this experiment provides support to this contention.

The next important significant effect is that of groups x distractors, F (2,23) = 6.98, $p < .00$. For a clear projection of this interaction effect, see Figure 4.2.3. It is observed that in the unfilled delay condition the difference is small between the two groups, while identical latency rates are obtained for the verbal distractor task. For the tactual distractor task, however, the sighted and blind groups are vastly different with

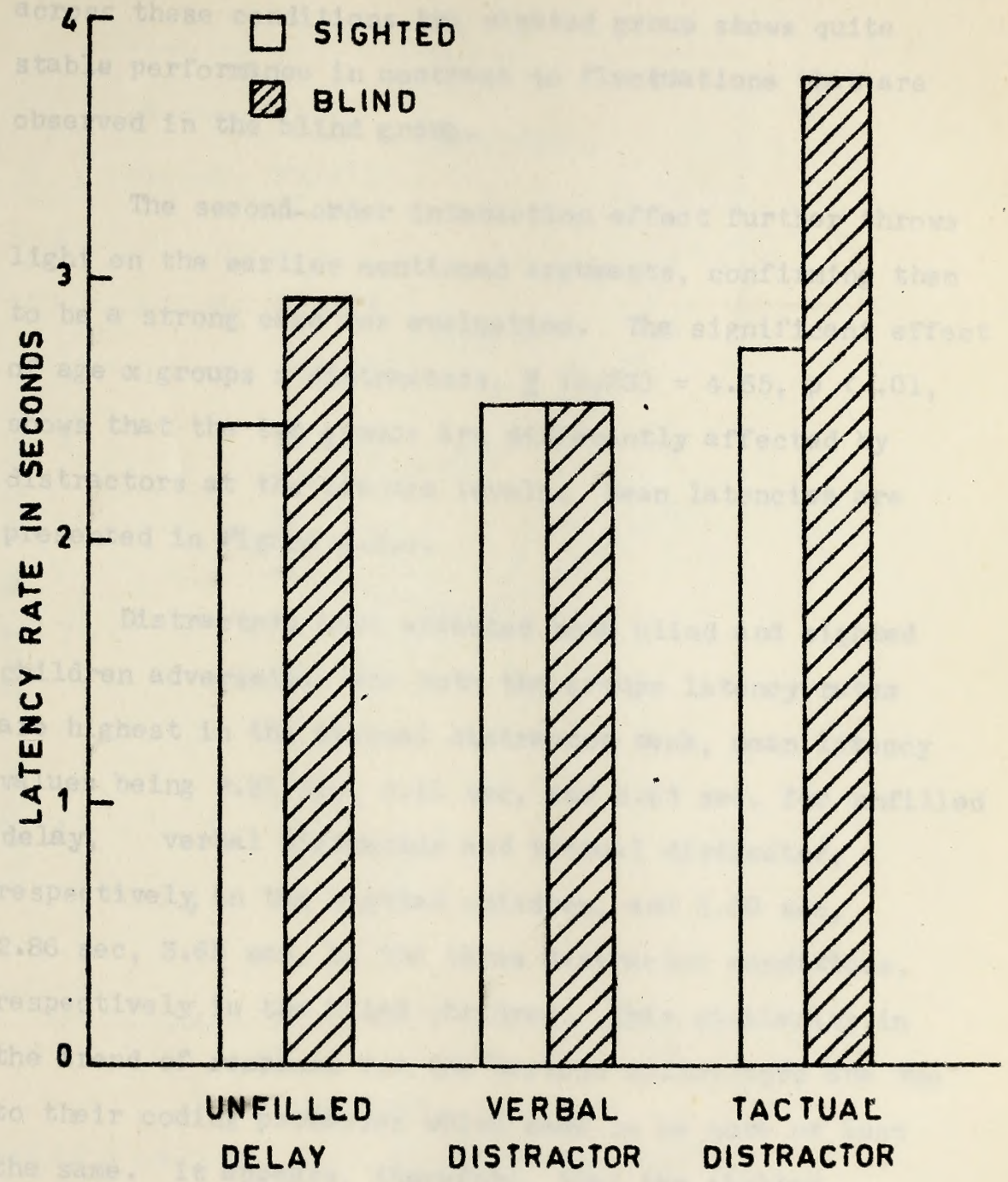


FIG.4.2.3 LATENCY RATE OF BLIND AND SIGHTED SUBJECTS ON VARIOUS DISTRACTORS

FIG.4.2.3 LATENCY RATE OF BLIND AND SIGHTED SUBJECTS ON VARIOUS DISTRACTORS

2.71 sec and 3.76 sec latency scores, respectively. Hence, across these conditions the sighted group shows quite stable performance in contrast to fluctuations that are observed in the blind group.

The second-order interaction effect further throws light on the earlier mentioned arguments, confirming them to be a strong case for evaluation. The significant effect of age x groups x distractors, $\underline{F}$ (2,23) = 4.65, $p < .01$, shows that the two groups are differently affected by distractors at the two age levels. Mean latencies are presented in Figure 4.2.4.

Distractors have affected both blind and sighted children adversely. For both the groups latency rates are highest in the tactual distractor task, mean latency values being 2.31 sec, 2.11 sec, and 2.63 sec, for unfilled delay, verbal distractor and tactual distractor, respectively in the sighted children, and 3.00 sec, 2.86 sec, 3.65 sec, in the three distractor conditions, respectively in the blind children. This similarity in the trend of response for the various distractors are due to their coding processes which seem to be more or less the same. It appears, therefore, that the sighted children have not yet developed efficient strategies for intermodal processing in memory. Another important observation from the figure is that blind subjects are consistently poorer than their sighted counterparts.

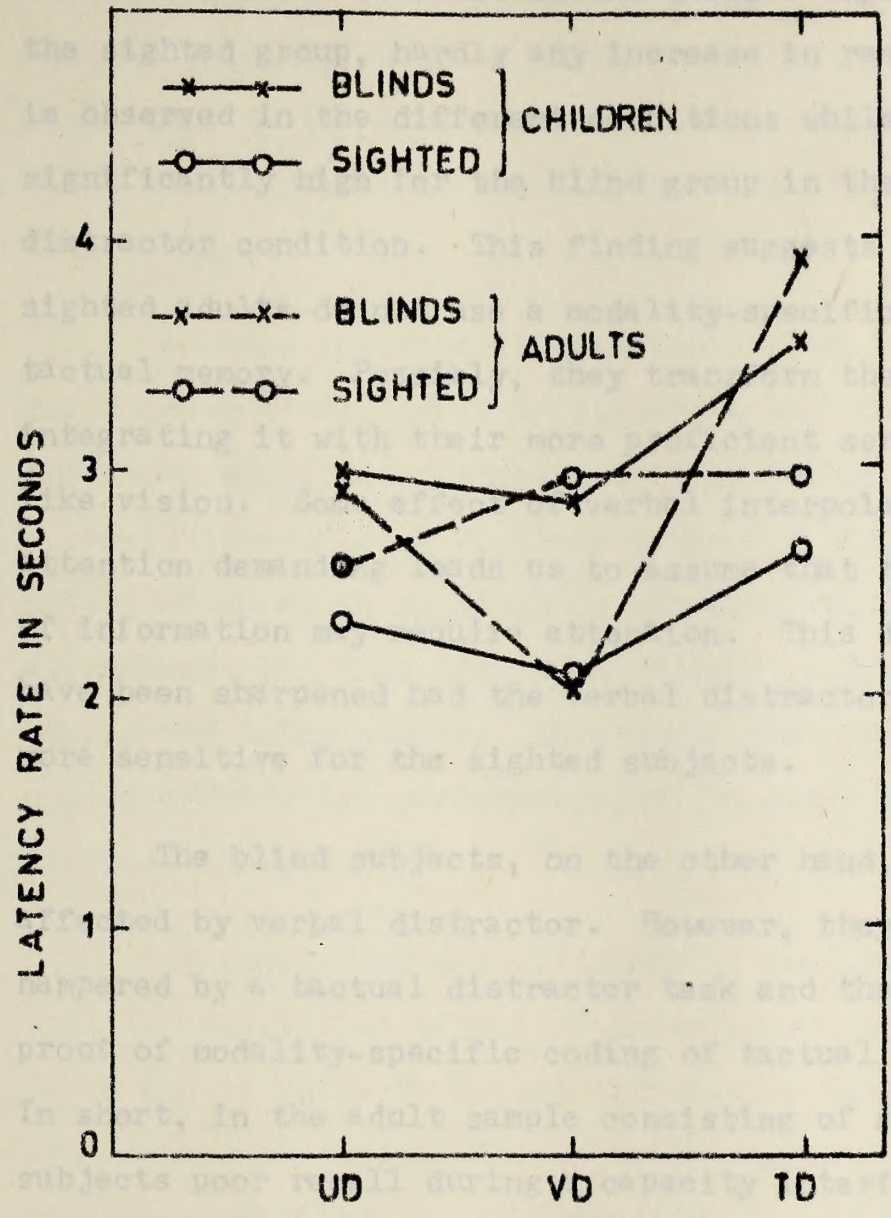


FIG.4.2.4 LATENCY RATE OF BLIND AND SIGHTED CHILDREN AND ADULTS ON VARIOUS DISTRACTORS

FIG.4.2.4 LATENCY RATE OF BLIND AND SIGHTED CHILDREN AND ADULTS ON VARIOUS DISTRACTORS

The data of the adult groups are well in conformity with the results obtained in the earlier experiment. In the sighted group, hardly any increase in response latency is observed in the different conditions while it is significantly high for the blind group in the tactual distractor condition. This finding suggests that the sighted adults do not use a modality-specific store for tactual memory. Possibly, they transform the material integrating it with their more proficient sensory modality like vision. Some effect of verbal interpolation that is attention demanding leads us to assume that this transfer of information may require attention. This difference could have been sharpened had the verbal distractor task been more sensitive for the sighted subjects.

The blind subjects, on the other hand, are least affected by verbal distractor. However, they are badly hampered by a tactual distractor task and thereby give a proof of modality-specific coding of tactual information. In short, in the adult sample consisting of sighted subjects poor recall during a capacity interference task is recorded, while the blind subjects of the same age group show structural interference in memory. This suggests an altered coding process with the presence or absence of a visual reference system.

At the lower age level, tactual information appears to be coded and stored in a tactual store. But with increase in age, the sighted subjects shift their coding and storage mechanisms to the more dominant mode of vision. Since the blind adults cannot do so, they prominently show structural interference.

Another positive interaction effect, though unable to reach conventional level of significance, also substantiates the above mentioned discussion. This concerns age x groups x recall intervals, F (1,23) = 2.93, $p < .08$. Deleterious effect of delay is observed in the blind children's response as compared to other groups of sighted children, sighted adults and blind adults. This shows that the nature of coding affects the performance of the two groups with increase in age.

In short, the main findings of the present experiment are: (a) dissimilar effect of distractors for groups is found and it reflects coding differences between the blind and sighted subjects. This clearly suggests that tactual retention of blind subjects tends to be modality-specific, but not so in the sighted. (b) Age emerged as a very significant factor for sensory development and integration which is quite clear when observed in relation to sighted and blind subjects. While the blind become efficient in

tactual coding with age, the sighted tend to develop modality-integration in memory. (c) In certain cases, effect of delay is also found in relation to distractors.

EXPERIMENT 4.3

So long an attempt was made in the previous two experiments to seek a clear answer for hitherto a sensitive problem of coding of tactual material with and without the support of vision at various levels of development. While doing so the effects accruing from delay in recall was also studied at two intervals, i.e. 5 and 30 sec. In the review reported earlier on tactual retention it was mentioned that for the first 10 sec, performance did not differ in rest and activity conditions but this was not so with further delay (Gilson and Baddeley, 1969). This suggests a possibility of two separate processes - one a fading sensory trace, and the other depending on rehearsal. From the results obtained in the previous two experiments it is very clear that the delay of 30 sec was more harmful than that of 5 sec but it remains to be seen how the difference between blind and sighted subjects could be traced to their sensitivity to recall the tactual material from the beginning to various delay periods. Again, if verbal and tactual distractors are really sensitive variables in the differential coding of the blind and the

sighted people these would automatically show out in the degree of efficiency with which such material is recalled at short or long delay. In other words, the effects of dissimilar coding in the two groups are supposed to bear relationship with the nature of interpolated activity.

In short, the aim of this experiment is to tap the efficiency of recall of the blind and sighted subjects on tactual tasks at various recall intervals and to show how this could be related to the nature of interpolated activity. To avoid the effects of age variable, the age group in this experiment is raised to 13-16 years, which is safe enough in view of the finding of Experiment 2.

Method and Procedure

Sample. A total of 80 high-school children between the age group of 13-16 years were used in this experiment, amongst which 40 subjects were blind and 40 were sighted. The number of males and females participated in this experiment was equal.

Apparatus and Material. Materials and apparatus were same as used in Experiments 4.1 and 4.2.

Experimental Design and Procedure. A 3-way 2 x 2 x 5 within subject design consisting of groups (sighted or blind) x interpolated activities (verbal distractor or tactual

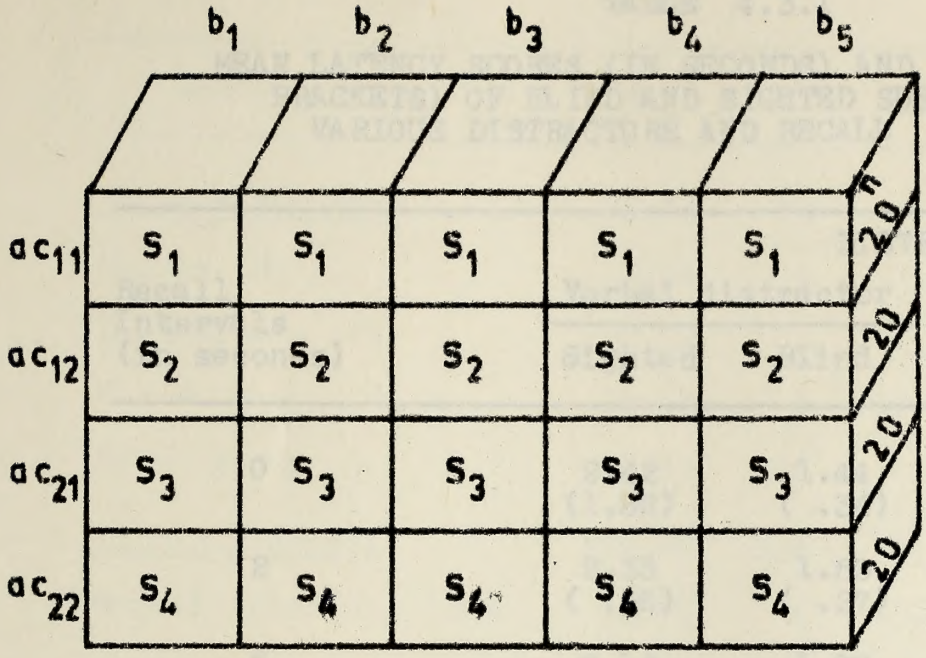
distractor) x delay intervals (0, 2, 5, 10 or 30 seconds) was used with the last factor being a within-subject condition (Fig. 4.3.1).

A set of 20 subjects participated in each of the 4 conditions with delay intervals randomised across each interpolated activity. Thus, each subject had to perform 10 trials with two trials per delay interval. This was completed in one session with an inter-trial interval of one minute each. Interpolated activities (verbal and tactual distractors) and responses recorded were the same as reported in Experiment 4.1. Appendix 4.III shows the raw-scores obtained here.

Results and Discussions

Response latencies obtained in this experiment (Mean and S.D.) are presented in the Table 4.3.1. These scores were further subjected to statistical test of significance of difference. Table 4.3.2 shows the summary of ANOVA obtained for these values which are very consistent with the earlier experiments. Main variable of groups is not significant, but conditions are highly significant, $\underline{F}$ (1,76) = 19.06, $p < .01$, besides recall intervals, $\underline{F}$ (4,304) = 27.62, $p < .01$.

Identical to the results obtained in the earlier Experiments (4.1 and 4.2), it is observed here that



a) GROUP
1) SIGHTED
2) BLIND

b) DELAY INTERVAL
1) 0 SECONDS
2) 2 SECONDS
3) 5 SECONDS
4) 10 SECONDS
5) 30 SECONDS

c) INTERPOLATED ACTIVITY
1) VERBAL DISTRACTOR
2) TACTUAL DISTRACTOR

N = 80 (40=SIGHTED / 40= BLIND)

FIG.4.3.1 DESIGN FOR EXPERIMENT 4.3

4.51

TABLE 4.3.1

MEAN LATENCY SCORES (IN SECONDS) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED SUBJECTS UNDER VARIOUS DISTRACTORS AND RECALL INTERVALS

Recall Intervals (in seconds)	DISTRACTORS			
	Verbal distractor		Tactual distractor	
	Sighted	Blind	Sighted	Blind
0	2.42 (1.88)	1.44 (.34)	2.45 (.73)	1.63 (.43)
2	2.33 (.56)	1.53 (.27)	2.66 (1.09)	1.92 (.36)
5	2.12 (.56)	1.80 (.41)	2.33 (.77)	2.51 (.54)
10	2.56 (.87)	2.12 (.45)	2.51 (.92)	3.36 (.77)
30	2.48 (.87)	2.66 (.82)	2.56 (.57)	3.97 (.81)

TABLE 4.3.1

MEAN LATENCY SCORES (IN SECONDS) AND S.D. (GIVEN IN BRACKETS) OF BLIND AND SIGHTED SUBJECTS UNDER VARIOUS DISTRACTORS AND RECALL INTERVALS

Recall Intervals (in seconds)	Verbal distractor		Tactual distractor	
	Sighted	Blind	Sighted	Blind
0	2.42 (1.88)	1.64 (.84)	2.48 (.73)	1.62 (.45)
5	2.33 (.86)	1.84 (.27)	2.66 (1.09)	1.88 (.76)
5	2.12 (.86)	1.80 (.41)	2.32 (.77)	2.21 (.84)
10	2.86 (.87)	2.12 (.49)	2.31 (.92)	2.32 (.77)
30	2.48 (.87)	2.06 (.82)	2.58 (.37)	2.17 (.80)

TABLE 4.3.2

SUMMARY OF ANOVA OF EXPERIMENT 4.3

Source	Ss	df	ms	F	P
Between subjects	78.00	79			
Groups (G)	1.64	1	1.64	2.69	
Distractors (D)	19.09	1	19.09	31.30	.01
G x D	10.95	1	10.95	17.95	.01
Ss.w. group	46.32	76	.61		
Within subjects	236.90	320			
Recall Intervals (RI)	49.71	4	12.43	27.62	.01
G x RI	39.42	4	9.86	21.91	.01
RI x D	4.85	4	1.21	2.69	.05
G x D x RI	6.08	4	1.52	3.38	.05
RI x Ss.w. x Groups	136.84	304	.45		

groups x distractors are highly significant, F (1,76) = 17.95, $p < .01$. The mean response latencies shown in Figure 4.3.2 leave no doubt about the differences in performance between the two groups on the distractors employed. Another first order interaction of distractors x recall intervals is also significant, F (4,304) = 2.69, $p < .05$, which is identical to Experiment 4.1. Mean response latency values shown in Table 4.3.3, suggest that with lapse of time, the tactual distractor task requires higher latency rates than those of the verbal distractor task.

A unique finding in this experiment is that of groups x recall intervals, F (4,304) = 21.91, $p < .01$. Figure 4.3.3 shows the mean latencies obtained for this experiment. It is absolutely clear that the sighted are quite consistent in their response time, while a steep rise with delay is noticed in the response latency of the blind subjects. This finding confirms the hypothesis drawn on the basis of earlier findings, namely when the coding is vision dependent, the response pattern is different than when it is touch dependent. Here, an evidence of tactual retention is found which is a function of fading sensory trace similar to those of Gilson and Baddeley's (1969) results.

This issue is further elaborated in the second-order interaction of groups x distractors x delay, F (4,304) = 3.38, $p < .05$, illustrated in Figure 4.3.4. These obtained

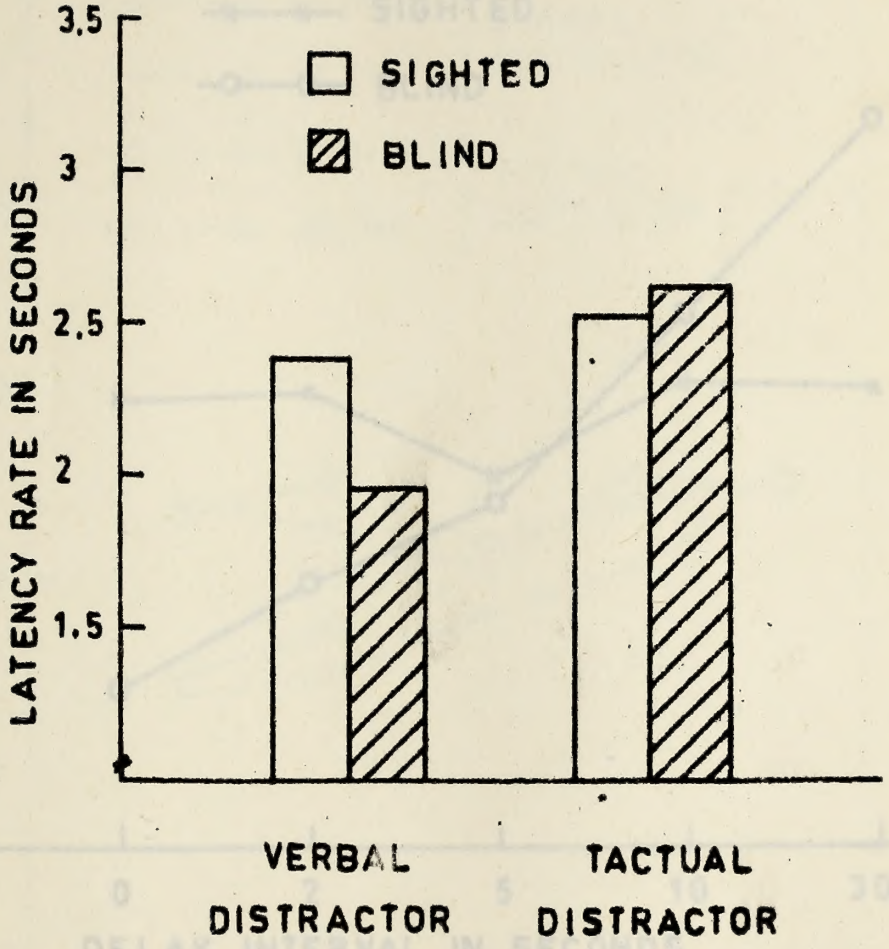


FIG.4.3.2 LATENCY RATE OF SIGHTED AND BLIND GROUPS ON DISTRACTORS

FIG.4.3.2 LATENCY RATE OF SIGHTED AND BLIND GROUPS ON DISTRACTORS

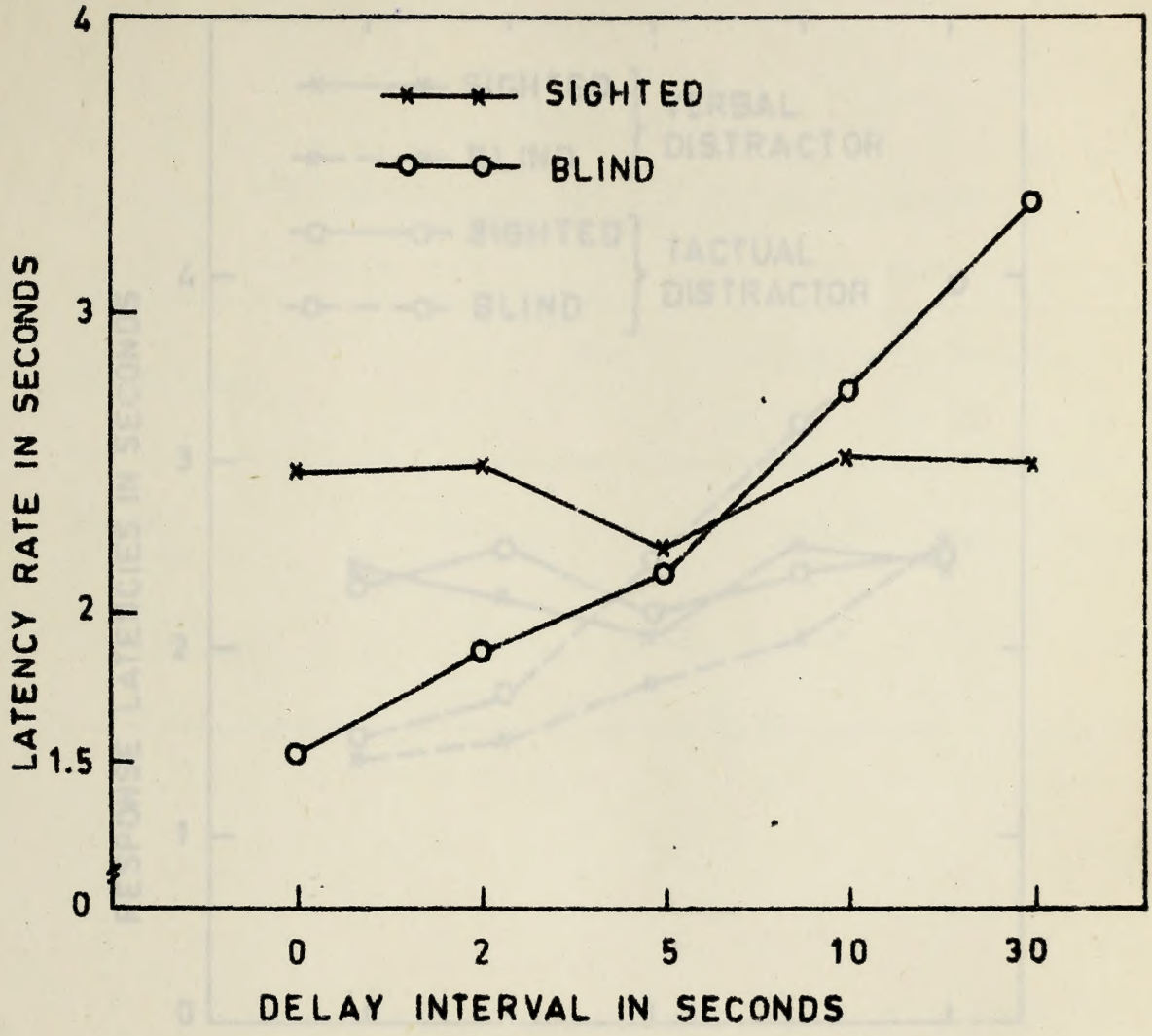
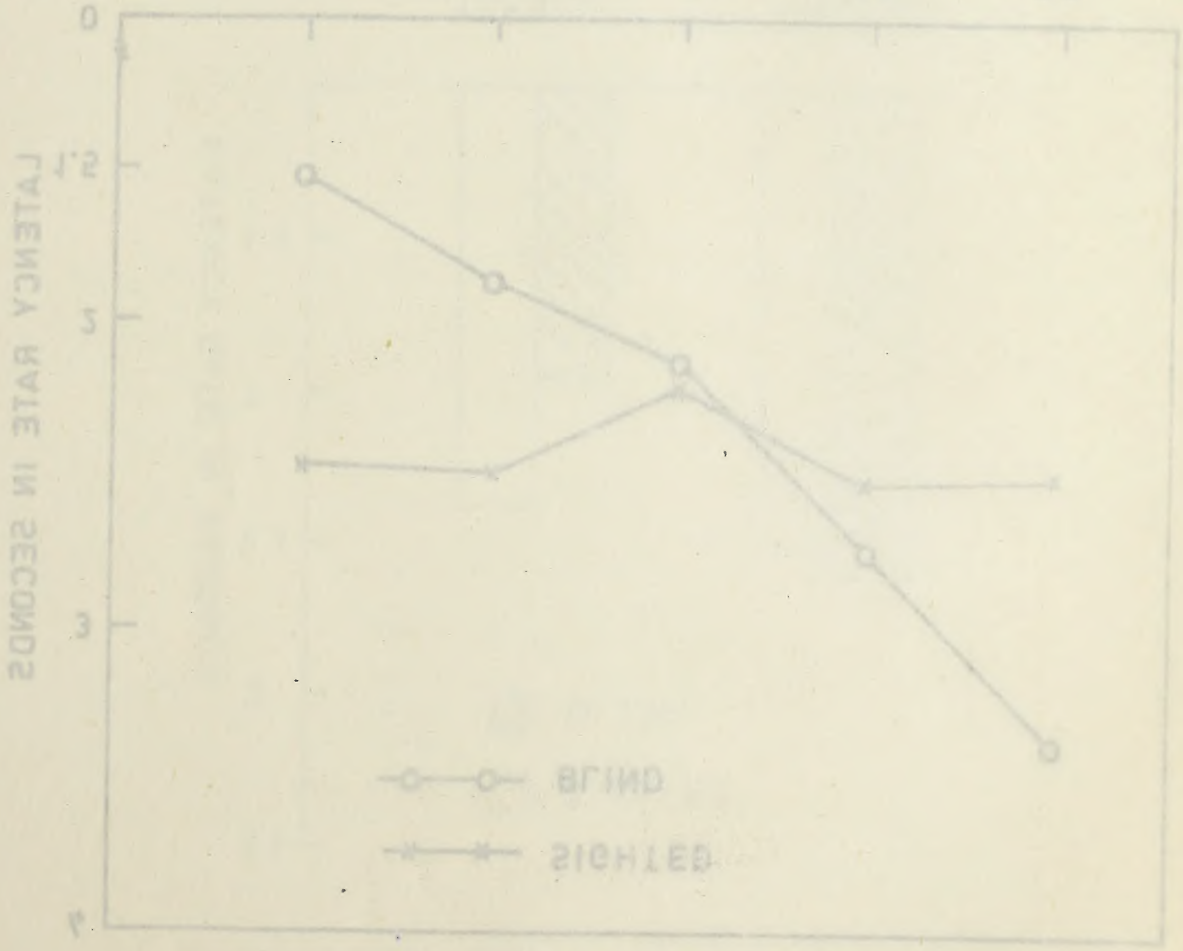


FIG.4.3.3 LATENCY RATE OF BLIND AND SIGHTED SUBJECTS ON INCREASING DELAY INTERVALS.


0
1.2
3
BLIND
SIGHTED

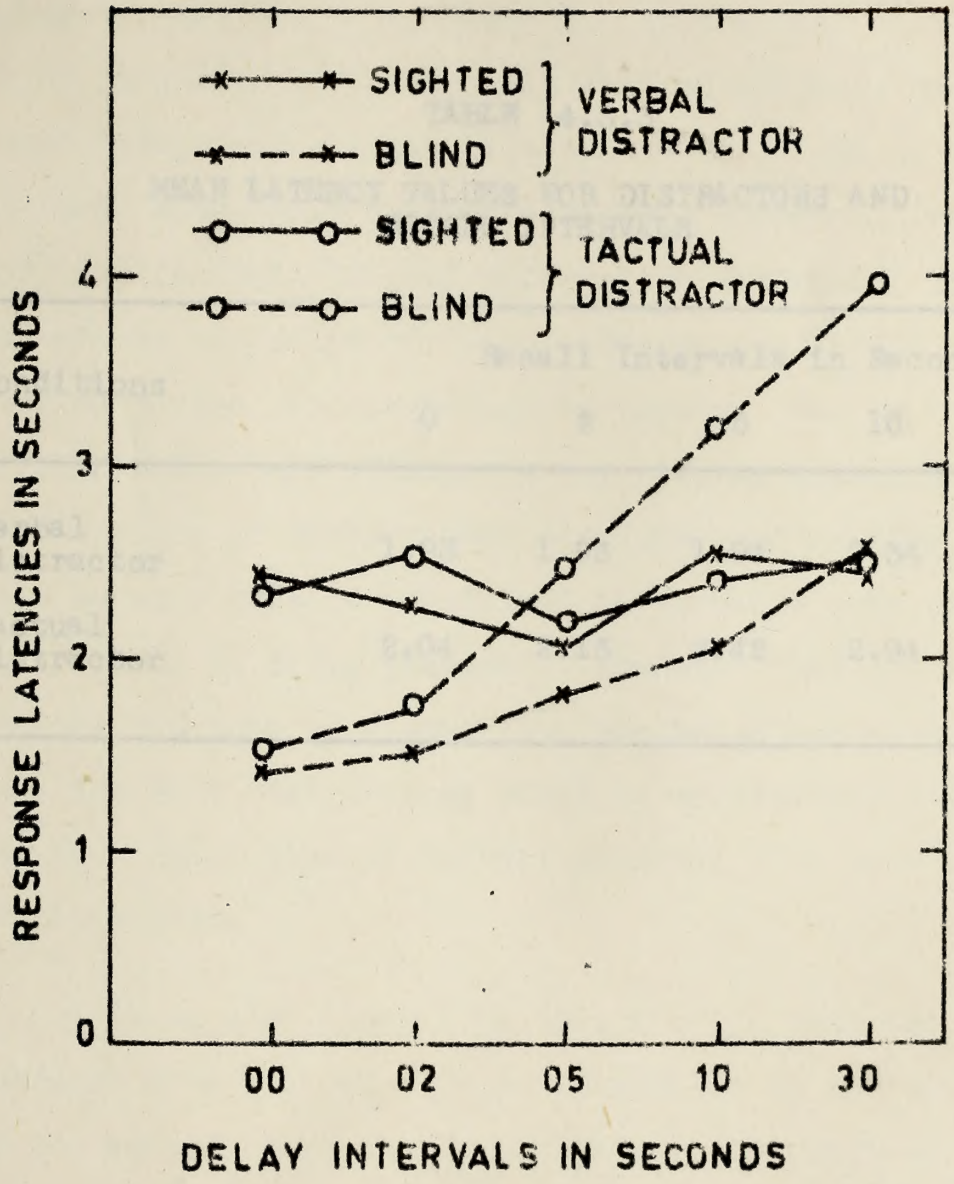


FIG. 4.3.4 LATENCY RATE OF BLIND AND SIGHTED SUBJECTS ON INCREASING DELAY INTERVAL FOR VARIOUS DISTRACTORS

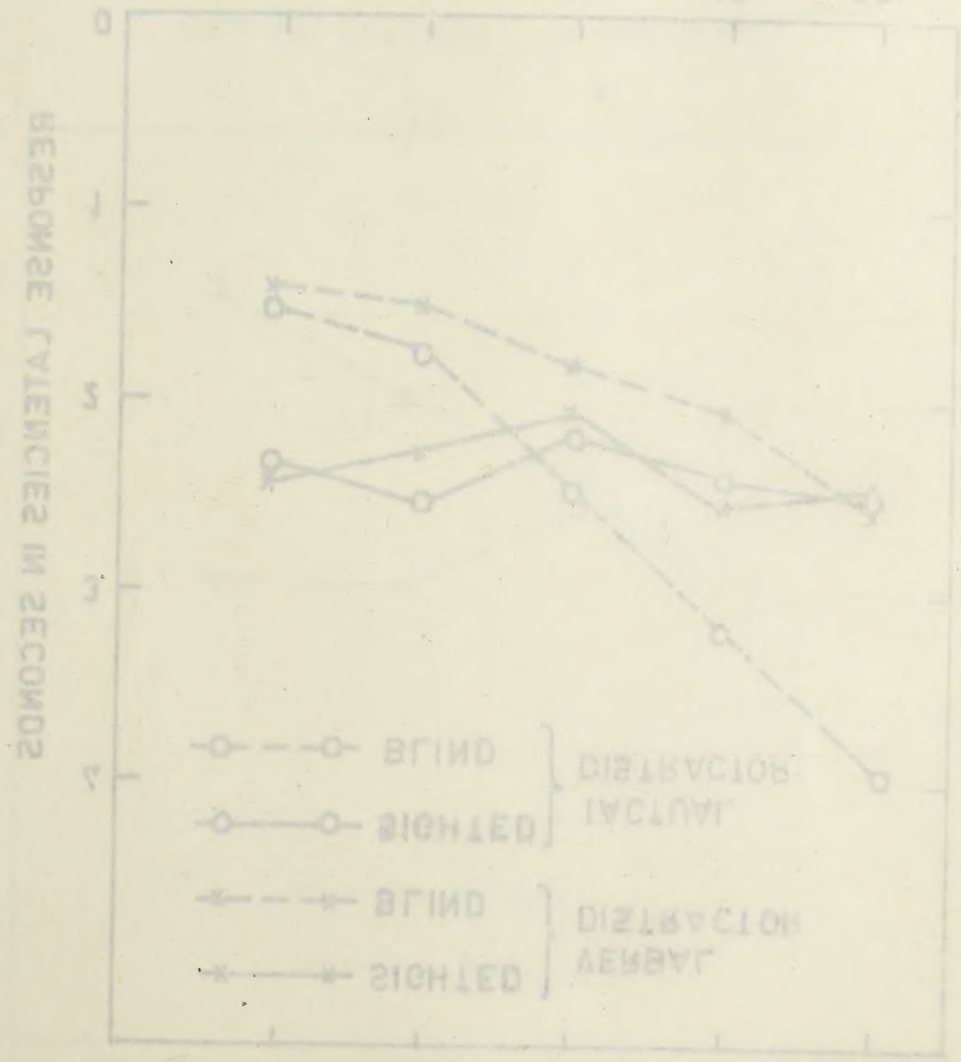

BLIND
SIGHTED
BLIND
SIGHTED

TABLE 4.3.3

MEAN LATENCY VALUES FOR DISTRACTORS AND RECALL INTERVALS

Conditions	Recall Intervals in Seconds				
	0	2	5	10	30
Verbal distractor	1.93	1.93	1.94	2.34	2.57
Tactual distractor	2.04	2.15	2.42	2.94	3.27

results point out that distractors do not have identical effects on response latency of the blind and sighted subjects over the delay periods. In the case of blind group, response is faster than sighted subjects upon short delays but a steep rise upon long delays is observed in them, especially so in the tactual interpolation task. This implies that tactual information has weaker storage and should be integrated with other properties if it has to find better representation in memory. Due to an efficient strategy adopted by the sighted subjects with the availability of their visual reference system they are able to show quite a consistent performance even with an increase in delay interval. The fact that their initial response is slower than the blind subjects draws home the fact that latency would be necessarily higher for the integration of tactual material in a more familiar mode.

It is also clear from this finding that the blind subjects have reached a level comparable to the sighted by the age of 13-16 years, as against the previous finding based on a sample of 9-11 years. In general, these findings are similar to those obtained on the adults in terms of modality-specific coding by the blind groups.

GENERAL DISCUSSION

It is clear from the results of the above reported 3 experiments that the overall performance of the blind adults as against the sighted is equal in the retention of nonsense shapes by touch. This evidence is gathered from the findings of experiments 4.1 and 4.3 in which very young children were not utilized. In the second experiment also, the adult subjects of the two groups do not show a difference in their overall performance. In the case of the children's sample, however, differences have been observed. The blind children were found to be less efficient showing that lack of visual experience causes handicap in them, and that tactual coding does not develop efficiently in them so as to compensate for deficiency in other sense modalities. However, when they grow older, as in the case of children in Experiment 4.3 (13-16 years) their tactual coding becomes efficient and habitual and helps them to cope up with their environment effectively. A strong point supporting this generalization is the fact that notwithstanding interference within their tactual sense modality, blind subjects show relatively superior performance than their sighted counterparts, particularly at short recall intervals. There is enough research evidence to show that children adopt efficient coding of the same material as they grow older (Kool and Agarwal, 1979). Their encoding becomes automatic when the structure

corresponds to the one generally used by subjects in a task. It is, therefore, not surprising that the sighted subjects in the older age group of 13-16 years show higher response latency than their blind counterparts. Numerous findings show that blind subjects may acquire tactual skills later than the sighted but ultimately may develop ability to equate performance, or even surpass, them have been demonstrated by other investigators also (Worchel, 1951; Gomulki, 1961; Brown, 1968). The insight one gets from the reported findings of the above experiments concerning failure to explain why blind people are inferior to sighted or vice versa or equal, is that as the utilization of a coding mechanism undergoes change from one modality to another or within the same modality, it becomes sharpened, and therefore the level of performance of a group is affected. That is to say, one should not be surprised if the difference between the two groups are not observable as reported by some (Evart and Carp, 1963), while others have reported superior performance by the blind subjects over the sighted group (Plata, 1942; Foulke and Warm, 1967; Pick and Pick, 1960).

The results of the Experiment 4.2 suggest a lack of sensory integration in the sighted children. Support for this amongst young children comes from developmental studies dealing with sensory integration (Piaget, 1952).

Such studies held that sensory integration may be present at birth, which is followed by sensory independence, and subsequently integration is relearnt through experience and language (Hermelin and O'Connor, 1978). Similar development has also been suggested by others (Birch and Leeford, 1963; Gibson, 1969). Therefore, some what in consonance with earlier evidences, a demonstration of sensory integration in later years is envisaged as a potential explanation in this investigation, too.

In general, the findings concerning coding processes in tactual retention reveal consistent differences between the sighted and blind groups. The blind people are less affected by distractors which are verbal while they are more sensitive when interference is in the same modality. Since the loss is quicker with interference in the same modality, there is reason to believe that modality-specific effects contribute to the coding of information in memory. On the other hand, the sighted group fail to show any clear difference between the distractors. An indication of high response latency is observed for the verbal distractor only at short recall interval (Experiments 4.1 and 4.2). This finding seems to suggest that sighted subjects, while coding the nonsense tactual shapes in some visual form, tend to be somewhat retarded. Since the overall performance is also not very different in the two distractors it may be said that they adopt strategies to integrate information in their preferable ways.

The generalization offered by Millar (1977) that '... there is not only frequently no difference between the blind and blindfolded sighted subjects in recognizing tactual shapes; more importantly they can be affected in the same way by distractors' (pp.131) apparently requires qualification at various age levels, as has been the case with the results reported here. Subjects having specific handicap's who lack appropriate representation codes, will tend to use different coding strategies than those able to evoke such codes. So, if sensorily handicapped children are examined through one of the intact sense modality they can surely perform as efficiently as those with no impairment.

Loss of superiority of blind subjects over their sighted counterparts at the delayed recall intervals (Experiment 4.3) show that the sensory input is initially better held in blind children. With increase in time, however, the loss is very rapid. The sighted group failed to show any difference between the two distractors upon delay in recall. It may also be suggested that the nature of verbal distractor, being a little less sensitive, could not reveal the differences clearly. However, there is enough evidence to show that coding strategy of the sighted subjects is supported by their knowledge of spatial layout, based on visual experience.

In fact, intimate linkage of tactual information into visual modality is reported by several investigators (Attneave and Benson, 1969; Sullivan and Turvey, 1972; Millar, 1974). It has been observed in the present experiments that such integration can take place for nonsense shapes also.

In summary, the following conclusions are drawn :

(1) Blind and sighted adults and old children do not differ on retention of nonsense figures by touch. However, young children upto 11 years in these groups differ, with blind group performing poorer than their sighted counterparts. This latter finding does not support some earlier results (Millar, 1974).

(2) Both blind and sighted people are not equally sensitive to various distractors. Blind people are less affected by a verbal distractor than a tactual distractor but no such specific effect is observed in sighted people (Experiments 4.2 and 4.3). Such a finding lends support to a modality specific explanation of coding.

(3) Blind people recall tactual shapes faster than their sighted counterparts. This is not surprising as they primarily rely on their sense of touch and become proficient in its use.

(4) Retention of tactual information is lost rapidly if it is not supported or integrated with some other source, i.e. visual, etc. The fact that blind people make use of their tactual sense much more efficiently and elaborately is amply proved by their superior performance at short recall intervals (Experiment 4.3) as compared to the sighted group, but with further delay in recall their performance deteriorates, particularly with a tactual distractor. Since blind people depend mainly, on their memory for touch, their retention of tactual shapes is susceptible to decay at long recall intervals.

(5) Blind and sighted groups differ in the nature of their coding. Whereas, the blind people show substantial loss in their retention with increase in recall delay for both verbal and tactual distractors, though of course not with same magnitude, the sighted people, on the other hand, do not seem to be affected to any significant degree from 0 sec to 30 sec intervals. It shows that the coding strategy of the sighted subjects has its support in spatial layout based on visual experience, and it is responsible for their superior recall accuracy.

SECTION II

KINESTHETIC AND TACTILE RETENTION

In the second part of the study the effect of touch and kinesthesis in single and bimodal presentation in memory has been examined. This cooperation of the supposedly separate sense of touch and kinesthesis is an old and controversial problem in psychology (Boring, 1942). Kinesthetic sensitivity refers to any movement information that involves spatial position occurring from mechanical stimulation of the mobile joints and muscles. Cutaneous sensitivity includes touch, pressure, temperature or pain. The cooperation of these two senses constitutes a very elaborate and complex perceptual apparatus.

An attempt has been made in this section to study the coupled effects of touch and movement. Two experiments were conducted on this problem and these are reported along with relevant studies which are concerned with either integration of information from various sense modalities or make an attempt to examine transfer effects from one sensory modality to another. The reader will find at some places that a number of studies and hypotheses in this section are mentioned without any detailed description. This is done because discussion of several studies and hypotheses described in the previous chapter overlap with the present series of experiments, and hence no repetition has been made.

4.63

FEEDBACK AUGMENTATION

Providing additional feedback in a specific modality or several sense modalities during learning is supposed to enhance retention and cause resistance to forgetting. Trace strength is considered to be the positive function of the amount of feedback (Adams, 1971).

Support for the abovesaid hypothesis could be obtained from a comparative study of feedbacks conducted by Adams, et al (1972 a) involving 5 feedback conditions i.e. auditory (A), proprioceptive (P), visual (V), all together (APV) and none (-APV). Substantial forgetting between 5 and 90 sec retention intervals occurred only under all feedback attenuated condition (-APV). The mean differences between following pairs were significant: APV vs. P, APV vs -APV, V vs P and V vs -APV. In all these pairs, former condition revealed superior recall. It was suggested that additional feedback results in superior recall and vision was relatively more advantageous. Adams, et al (1972 b) reported that feedback change affected the performance at both low and high levels of practice. They argued against the possibility of development of a motor program but favoured a closed-loop theory which stresses the role of feedback for all stages of learning. Support for this contention was also obtained in subsequent studies (Adams, Gopher, and Lintern, 1977; Diewert, 1976; Stelmach, 1973).

4.64 Roy and Marteniuk (1974) compared learning performance under changed or interrupted feedback and same feedback condition. They suggested that acquisition of fast movements is under control of motor programmes, while slow movements are under feedback control.

Contrary to previous findings, Kelso and Frekany (1978) reported that availability of vision had no advantageous effect in reproduction of constrained movement. Moreover, presence of vision caused deleterious effect on the recall of preselected movements. It was suggested that for the advantageous effect, vision should be present during both criterion and reproduction response. Interfering effect of vision for preselected movement retention was explained on the basis of simultaneous attention to vision and execution of movement plan. This study also reported that visual information in preselected mode was spontaneously attended only in the absence of precuing. This finding is somewhat similar to the one reported by Posner, et al (1976).

A study of additional cue utilization in young children (3 and 4 year old) for shape recognition was made by Millar (1971). Conditions of testing were (a) Visual and haptic-Visual (VH-V), (b) Visual-Visual (V-V), (c) Haptic-Visual (H-V), (d) Visual and Haptic-Haptic (VH-H), (e) Haptic-Haptic (H-H), (f) Visual-Haptic (V-H). Results indicated superior performance of the visual modality over

4.65 haptic under all possible comparisons: Standard, recognition and intramodal. Visual recognition was not improved when haptic cues were added but haptic recognition by 4 year olds improved when visual cues were added. These findings supported Gibson's view (1969) that visual recognition was was not facilitated by touch and manual explorations.

INTRAMODAL AND CROSSMODAL TRANSFER

Some studies have examined transfer of information between and within sensory modalities. Connolly and Jones (1970) involved a movement length estimation task in which the mode of information presentation and the mode of reproduction were varied. This made 4 transfer conditions i.e. visual-visual (V-V), Kinesthetic-Kinesthetic (K-K), Visual-Kinesthetic (V-K) and Kinesthetic-Visual (K-V). The first two conditions were referred as intramodal, while the other two as crossmodal. He found that V-V and K-K condition did not differ in terms of the accuracy and variability and both of them were superior to K-V and V-K crossmodal conditions. He also reported a crossmodal assymmetry, i.e. performance under K-V condition was superior to V-K condition. They proposed that crossmodal condition involves recoding or translation of information from one modality to another and therefore, crossmodal judgement is inferior to intramodal judgement. They proposed that this translation occurs immediately after presentation and

4.66 before being stored in modality specific short-term memory. They explained superior performance under K-V condition on the basis of Posner's (1967) results which showed more precise coding of visual information than kinesthetic information. Jones and Connolly (1970) studied the retention of visual and kinesthetic-visual crossmodal conditions over a 20 sec interval and confirmed their previous model (1970). Newell and Shapiro (1975) failed to get differences between V-K and K-V transfer conditions but supported other results of Connolly and Jones (1970).

Diewert and Stelmach (1977) used a linear movement task and reported that intramodal and crossmodal estimations differed only on long targets, crossmodal transfer being inferior to intramodal transfer. He also found difference between K-V and V-K only on long distances, V-K being superior to K-V transfer. They supported a model characterized by little difference in transfer ability except at long distances.

Marteniuk and Rodney (1979) examined intramodal and cross-modal transfer under minimized visual information condition and reported that intramodal transfer was superior to crossmodal. In this experiment, crossmodal assymmetry was found absent which led them to conclude that superiority of K-V over V-K is contingent to the amount of information present for the most adept modality.

4.67 With increase in visual information in another experiment, their results were identical to Connolly and Jones (1970). In short, these researches emphasized the role of the amount of information rather than adeptness.

Newell, et al (1979) found almost similar results to that of Marteniuk and Rodney (1979) but differed as the former rejected the translation phenomenon of Connolly and Jones (1970) because they found difference in estimation by varying the time of information to the subject about the recall modality. This led them to conclude that translation does not occur immediately after the presentation of information and before being stored in modality specific short-term memory.

Pick (1970) explained crossmodal effects on the basis of the necessity of recoding or translation of information. He further argued that translation occurs to the best suited modality. It was suggested by Goodnow (1971) that modality superiority depends upon the experience of working in a modality. She found that delay in recall deteriorated the performance of the sighted subjects on a tactual task but did not affect performance of the blind people. She proposed that the modalities serve as sampling procedures and modality superiority is determined by the extent to which it samples the salient and crucial informations. Working along these lines, Millar (1972)

4.68 tested intramodal and crossmodal shape recognition on 3 age groups of children on (a) visual-visual (V-V), (b) haptic-visual (H-V), (c) visual-haptic (V-H), and (d) haptic-haptic (H-H) with interpolated activities also. She found that V-V matches were more accurate and quicker than H-V matches, but V-H matches were neither more accurate nor faster than H-H matches. She suggested on the basis of these results that coding was different in modalities and these could make cross-modal matches more liable to changes in strategy and make them less efficient. Her results suggest that crossmodal matches are limited by differences in discriminability and coding between modalities because they need extra decisions regarding which input to rely more and which to ignore depending upon the 'better' modality. Hence, the number and direction of such decisions would depend not only on coding strategies but also on coding differences between modalities which are not age dependent.

It may be observed that most of these studies dealing with intramodal transfer effects have used vision (the most dominant mode) as one of the modalities for comparison. It is therefore difficult to assume as to what may be the nature of coding when both informations are non-visual in nature. In this section the nature of the conjoint effect of cutaneous and kinesthetic system in memory have been studied.

4.69 EXPERIMENT 4.4

The first experiment in this series explored as to how well a movement could be retained when in contact with the skin? This integrated memory store was examined by directly comparing it with a simple kinesthetic movement. The objects of tactile perception while on a motion (i.e. bimodal information) may be studied if the observers hand lies passively, and an object of some sort is made to trace a path of pressure across the skin. In a situation where an object is moved on the forearm, the joints of the limb, wrist and, perhaps, the shoulder, are involved together to get the perception of a moving object. An observer would state that he perceived the movement by touch, although the only cutaneous stimulation he received was a continuous deformation of the skin on the forearm. Evidently, anatomically different receptive system in the skin and in joints are functionally activated for the experience of motion when they are passively stimulated by some external method (for details see previous chapter). The possibility remains therefore that such type of integrated information may show different processing strategies from those of a single modality processing capacity.

Research data available for studies dealing with perception of movement by touch are rather sparce and have only emphasized on identification between brushing, rolling,

4.70 rubbing, etc with various instruments which are discriminable (Gibson, 1962). This therefore necessitates an enquiry into the nature of the conjoint effect of cutaneous and kinesthetic systems in memory.

The interest in the internal representation of information that is sensory in origin has led psychologists to enquire as to how the brain transmits information about kinesthetic movements that are made. Numerous variables have been tested in this regard and the concept of 'preselection' has come into wide focus. (For details see previous chapter).

Studies have shown the superiority of a preselected movement over a constrained one (Jones, 1972; Jones, 1975; Marteniuk, 1973; Stelmach, et al, 1975; Kelso and Frekany, 1978; Stelmach, et al, 1976), and various explanations have been offered. The effect of preselected versus constrained movement were tested under single (kinesthetic) and bimodal (tactile-kinesthetic) task in the present experiment with a view to test the effect of preselection cue under different modes of recall.

Another aspect crucial to short-term memory studies have been that of its magnitude. Short movements have been known to yield overshooting response characteristics, whereas long movements are undershot. This tendency is labelled as 'range effects', a phenomenon first observed

4.71 by Pepper and Herman (1970) and investigated in detail by several others (e.g. Roy and Kelso, 1977; Stelmach and Wilson, 1970). (See Chapter 3 for details).

It has been also reported that short movements are more precisely coded than long movements (Adams and Dijkstra, 1966; Hermelin and O'Connor, 1975). Therefore, length of a movement forms an important dimension and has been examined in the present experiment. It was hypothesized that short and long targets would be guided differently by prior information cue or the one determined by the Experimenter.

A related aspect is that of directionality of estimation which is crucial in relation to prior information cue. In the experiments reported in the previous chapter it was found that preselected tasks were underestimated in comparison to constrained task which were mostly overestimated. This tendency was clear in the sighted subjects but not in the blind subjects. Given this finding an important issue regarding use of encoding a strategy on the basis of prior information among the sighted subjects to code the length of movement needs close scrutiny. This is particularly important because short or long movements show range effects without preselection in both blind and sighted groups but the two groups differ when preselection is involved. If this be the case, similar results are expected even upon shortening the total length of movement such that a short

4.72 movement of about 10 cm in the previous experiments tentatively becomes a long movement when about a 2 cm movement is categorized as a short one. If preselection involves cues other than kinesthetic, which is likely the case with the sighted people, their recall tendency would mirror identical characteristics which were observed in the earlier experiments in which the total length of movement was 3 to 4 times greater. In other words, preselection involves adopting a strategy to internalize the movement such that the range effect of overshooting or undershooting is not guided by the kinesthetic feedback alone arising out of movement in physical space but it is also supported by other sources like vision, etc.

In view of the above said it may be hypothesized that the blind and sighted groups would differ in their ability to derive benefit from tactile-kinesthetic modes presented with or without preselection. Additionally, their overshooting and undershooting tendencies would also be affected by target length and preselection.

Studies focussing on movement time have dealt with aspects as that of index of preprogramming (Schmidt, 1972). Similar issue has concerned others investigators also (Ellis, et al, 1968; Henry, 1961; Henry and Harrison, 1961). Movement time (MT) bears relationship with the length of distance and precision. As early as in 1954 Fitts proposed

4.73 a simple equation to compute the relationship between MT and distance. If MT is a sensitive measure of response, it is likely to show the difference between blind and sighted people. From the findings reported in the previous chapter and those in the first section of this chapter it is concluded that the blind subjects show a tendency to respond faster than their sighted counterparts and that as the length of movement increases and becomes feedback dependent, they commit fewer errors than the sighted subjects. These results suggest that efficient coding of movement by the blind subjects should be indexed in their lower MT than the sighted subjects. A significant point of interest is that sighted subjects, while deriving benefit from their visual reference system, fail to translate the visual source of distance to the actual movement. Highlighting this relationship between visual factor and movement organization, Keele (in press) wrote, " Movement time increases with distance and precision partly because the accuracy of translating the visual perception of distance to be covered to actual movement is limited. When the need for precision exceeds the inherent accuracy of this translation, then corrections based on visual feedback must be made as the target is neared, and those corrections take time." (p. 7).

4.74 Method and Procedure

Sample. A total of 75 adults subjects (35 blind and 40 sighted subjects) participated in this experiment.

Apparatus and Materials. A slide mounted on a 15 cm long scale was designed for this purpose[*] (Fig. 4.4.1). In a tactile-kinesthetic task this could be fastened on the subjects forearm, with velcro tapes attached to it. All these were mounted on a wooden base, which ensured steadiness with the arm on it. The subject moved the pointer with his left hand and hence received kinesthetic information, while the pointer touching the skin softly on the forearm gave tactile impressions of movement. In a kinesthetic task, this apparatus was placed in front of the subject. In this case the subject only moved the pointer and received kinesthetic information. A reaction timer and a buzzer were also electrically connected such that the start switch of the RT was connected to the buzzer and the 'stop' wire was connected with the starting point of the slider. Hence, pressing the start switch would give the auditory signal and simultaneously start the reaction timer, and as soon as the subject began his response the RT recorder would stop. Movement time was recorded by using a stop-watch. Degree of accuracy was noted from the variations obtained in the scale.

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[*]The apparatus was designed by Industrial Design Centre of Indian Institute of Technology, Bombay.

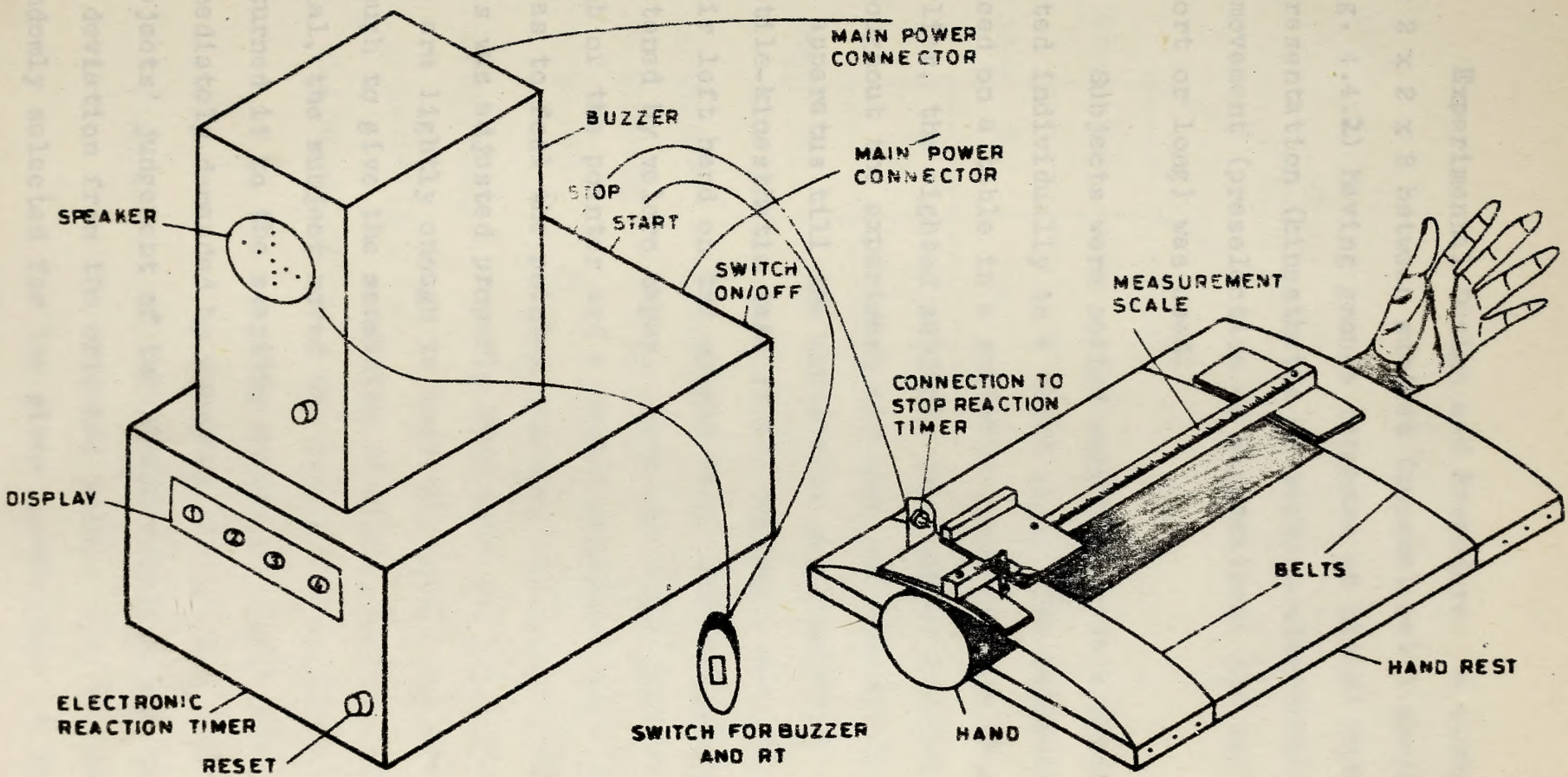
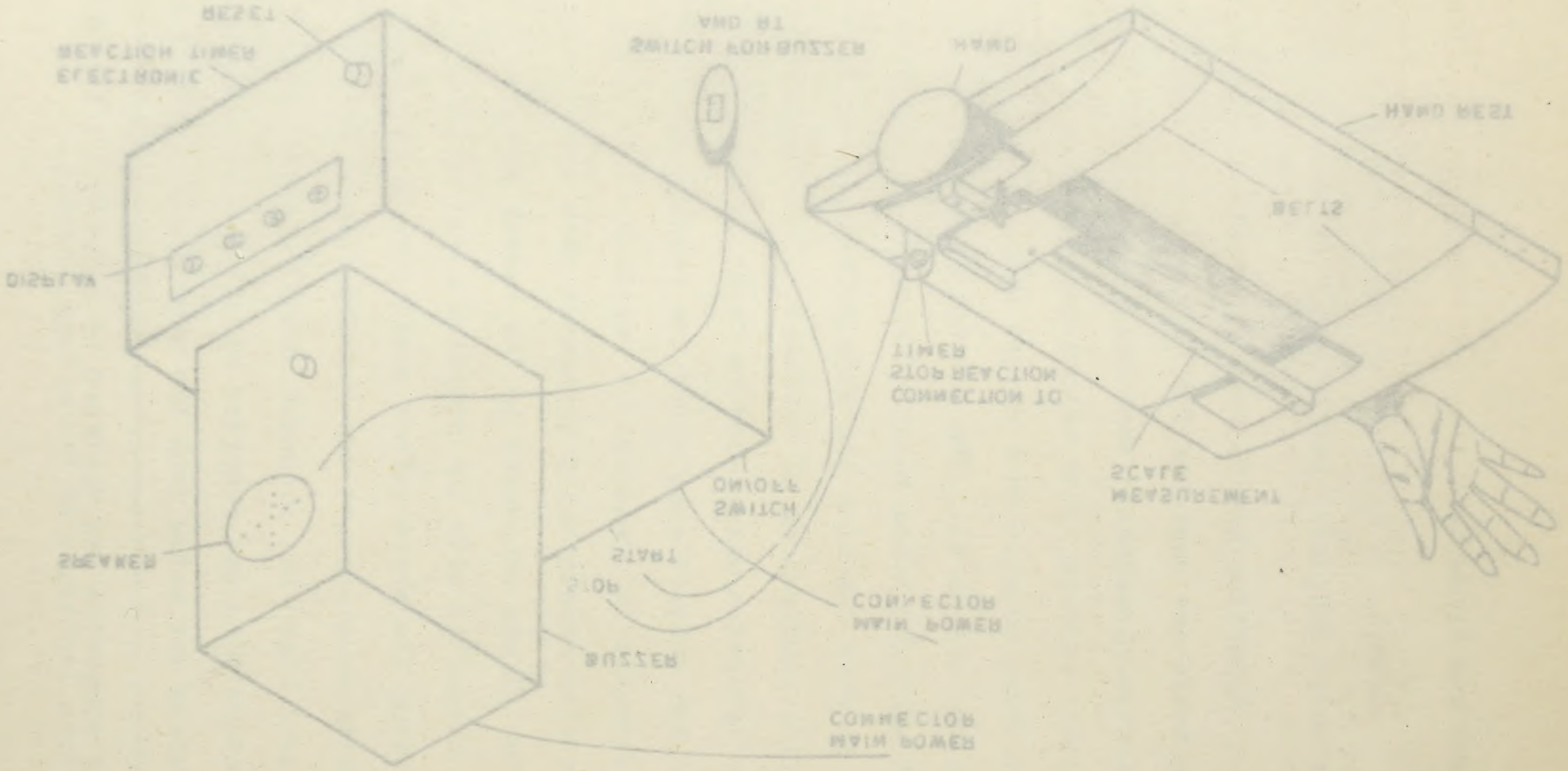
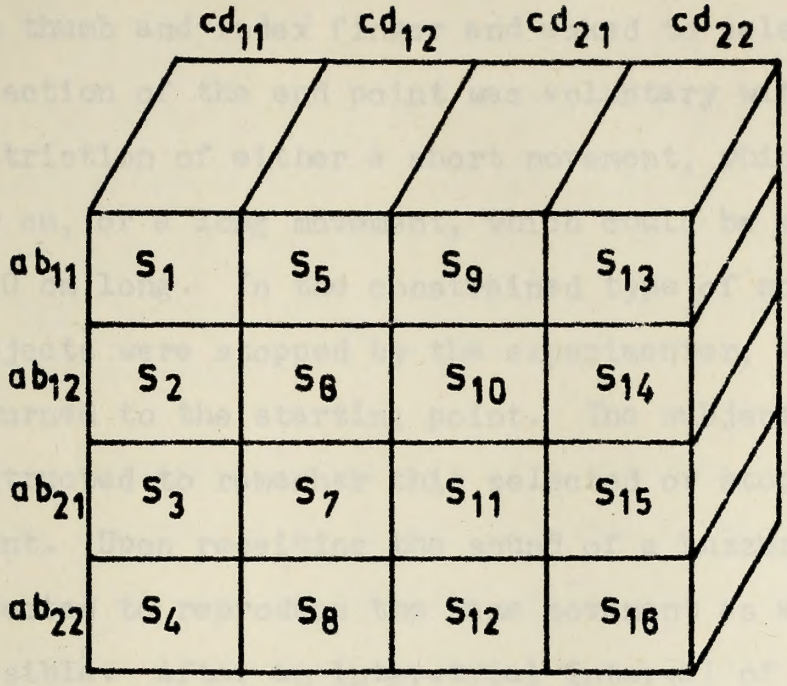


FIG. 4·4·1. ARM SLIDE DESIGNED FOR EXPERIMENT 4·4 AND 4·5.


RESET
REACTION TIMER
ELECTRONIC
HAND
HAND REST
REST
DISPLAY
SCANNER
START
CONNECTOR
MAIN POWER
BUZZER
CONNECTOR
MAIN POWER

4.75 Experimental Design and Procedure. A 4-way 2 x 2 x 2 x 2 between subject (unequal cell) design (Fig. 4.4.2) having groups (sighted or blind) mode of representation (kinesthetic or tactile-kinesthetic), type of movement (preselection or constrained) and sector (short or long) was used.

Subjects were seated comfortably in a chair and tested individually in a quiet room. The apparatus was placed on a table in a suitable distance. As mentioned earlier, the sighted subjects used opaque goggles throughout the experiment and were not allowed to see the apparatus till the experiment was completed. On the tactile-kinesthetic task (T-K), subjects were to place their left hand on the wooden base, their elbow and wrist fastened by velcro tapes. With the right hand he held the knob of the pointer and a familiarization trial was given so as to feel the pointer touching his entire forearm. This was adjusted properly such that the pointer touched the arm lightly enough to feel the touch, yet not deep enough to give the sensation of pain. For the criterion trial, the subject moved the pointer to a target point and returned it to the starting position. The response was immediately demanded by sounding the buzzer, and the subjects' judgement of the length recalled was noted in terms of deviation from the original point. All the subjects were randomly selected for the given conditions. A total of 5 trials were recorded per subject.



a) GROUP
1) SIGHTED
2) BLIND

b) MODE
1) KINESTHETIC
2) TACTILE – KINESTHETIC

c) TYPE OF MOVEMENT
1) PRESELECTED
2) CONSTRAINED

d) SECTORS
1) SHORT (0-2 cm)
2) LONG (8-10 cm)

N=75 (39 BLINDS/36 SIGHTED)

FIG.4.4.2 DESIGN FOR EXPERIMENT 4.4

cd_{11}
cd_{12}
cd_{21}
cd_{22}
ab_{11}
ab_{12}
ab_{21}
ab_{22}
S_1
S_5
S_9
S_{13}
S_2
S_6
S_{10}
S_{14}
S_3
S_7
S_{11}
S_{15}
S_4
S_8
S_{12}
S_{16}

4.76 The subjects were given separate instructions for the 2 types of movements. In the preselected task, the subjects were asked to hold the knob of the slider between the tip of his thumb and index finger and asked to select a movement. Selection of the end point was voluntary with the restriction of either a short movement, which was between 0-2 cm, or a long movement, which could be anywhere between 8-10 cm long. In the constrained type of movement, the subjects were stopped by the experimenter, after which he returned to the starting point. The subjects were instructed to remember this selected or stopped target point. Upon receiving the sound of a buzzer, they were expected to reproduce the same movement as accurately as possible. After an inter-trial interval of 1 minute, a different point in the same sector was tested under similar conditions. Therefore, similar procedures, as those followed in the preselected task, were adhered to in the constrained task with the following exceptions : (1) the command 'ready' was substituted for the command 'select', and (2) the end location was defined by the experimenter by placing a stopper at a target decided earlier.

In the present experiment the following conditions were tested: (a) Tactile-kinesthetic mode: When information about the movement was received both by touch sensations from the left arm and moving sensation by the right hand.

4.77 (b) Kinesthetic mode: When movement of the right hand was the only source of information. (c) Preselected type of movement: When the subject had to choose his own target point (subject-defined). (d) Constrained type of movement: When the subject was stopped by E at a given target point (Experimenter-defined). (e) Short sector: The subjects had to move only within a distance of a 2 cm range. (f) Long sector: The subject could move within a distance of 5-10 cm range.

Dependent Variables. The analysis of data centered around the CE and AE in the same way as described in the previous chapter. Additionally, movement time (MT) was simply the time recorded from the movement initiation till the subject stopped to indicate the criterion point. Appendix 4.IV shows the raw-scores obtained here.

Results and Discussion

Absolute Errors. Table 4.4.1 shows means and S.Ds. values of AE obtained in this experiment. To test the effects of each of the variables separately and conjointly, the data were subjected to statistical treatment of ANOVA, a summary of which is presented in Table 4.4.2.

The main variable of mode does not reach acceptable level of statistical significance, (Mean values: K = .61 cm, T-K = .53 cm) showing that additional information does not necessarily facilitate recall to a significant effect.

4.78

TABLE 4.4.1

MEANS AND S.D. (IN BRACKETS) OF ABSOLUTE ERRORS OF SIGHTED AND BLIND SUBJECTS ON MODES, TYPES OF MOVEMENT AND SECTORS IN EXPERIMENT 4.4

		Kinesthetic		Tactile-Kinesthetic	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
Sighted	Short	0.25 (0.09)	0.51 (0.16)	0.27 (0.11)	0.50 (0.17)
	Long	0.65 (0.25)	1.22 (0.51)	0.70 (0.32)	0.66 (0.17)
Blinds	Short	0.28 (0.13)	0.48 (0.23)	0.22 (0.08)	0.58 (0.22)
	Long	0.73 (0.21)	0.74 (0.23)	0.62 (0.22)	0.59 (0.12)

4.79

TABLE 4.4.2

SUMMARY OF ANOVA OBTAINED FOR AE IN EXPERIMENT 4.4

Source	Ss	df	Ms	F	P
Groups (G)	0.08	1	0.08	1.68	
Modes (M)	0.14	1	0.14	3.07	0.08
Sectors (S)	2.26	1	2.26	48.16	0.00
Types of Movement (TM)	0.69	1	0.69	14.78	0.00
G x M	0.02	1	0.02	0.47	
G x S	0.10	1	0.10	2.10	
G x TM	0.07	1	0.07	1.41	
M x S	0.20	1	0.20	4.30	0.04
M x TM	0.07	1	0.07	1.55	
S x TM	0.09	1	0.09	1.85	
G x M x S	0.02	1	0.02	0.31	
G x M x TM	0.17	1	0.17	3.71	0.05
G x S x TM	0.11	1	0.11	2.25	
M x S x TM	0.18	1	0.18	3.86	0.05
G x M x S x TM	0.04	1	0.04	0.86	
Within groups	2.8	59	0.05		

4.80 It is observed that a self-defined preselected (P) task is recalled with greater precision than a constrained (C = experimenter-defined) type of movement (Mean, P = .46 cm/C = .66 cm) and this variable has emerged highly significant in ANOVA, $\underline{F}$ (1,15) = 14.78, $p < .01$.

The variable of sectors is also highly significant in this experiment, $\underline{F}$ (1,15) = 48.16, $p < .01$, and clearly indicates that recall of short (S) and long (L) sectors are vastly different, the mean values being .39 cm and .95 cm for short and long targets, respectively.

An interesting finding in this study is the first-order interaction of mode x sectors, $\underline{F}$ (1,15) = 4.30, $p < .04$. In the short sector recall errors in the K and T-K conditions do not differ, but in the long sector this is not so (Mean for K and T-K being .84 and .65 respectively), Hence, facilitatory effects are observed in the recall of long targets of bimodal presentation but not in the short targets.

A spectacular finding in this analyses is the significant second-order interaction of group x mode x type of movement, $\underline{F}$ (1,15) = 3.71, $p < .05$ (Fig. 4.4.3). Scrutiny of these reproduction errors reveal that the sighted subjects in the preselected conditions have no additional advantage in the bimodal condition. In fact, bimodal presentation shows slight inhibitory effects on

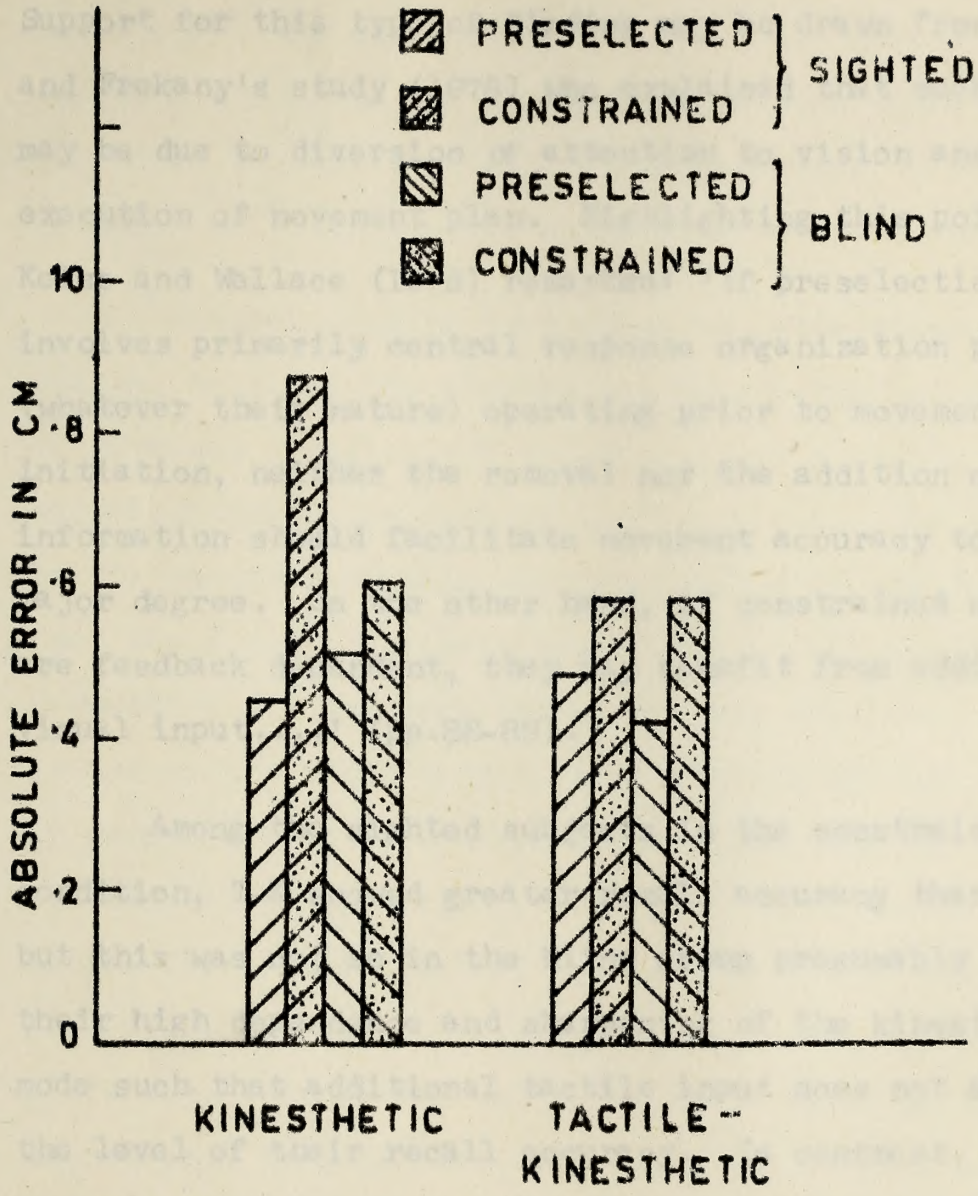


FIG.4.4.3 MEAN VALUES FOR TWO MODES OBTAINED ON PRESELECTED AND CONSTRAINED TASKS BY BLIND AND SIGHTED ADULTS

FIG. 4.4.3 MEAN VALUES FOR TWO MODES OBTAINED ON
PRESELECTED AND CONSTRAINED TASKS
BY BLIND AND SIGHTED ADULTS

4.81 voluntary reproduction of movements, the mean values being .45 cm and .49 cm for K and T-K tasks, respectively. Support for this type of finding may be drawn from Kelso and Frekany's study (1978) who explained that such a loss may be due to diversion of attention to vision and execution of movement plan. Highlighting this point Kelso and Wallace (1978) remarked: 'If preselection involves primarily central response organization processes (whatever their nature) operating prior to movement initiation, neither the removal nor the addition of sensory information should facilitate movement accuracy to any major degree. On the other hand, if constrained movements are feedback dependent, they may benefit from additional visual input....' (pp.88-89).

Among the sighted subjects in the constrained condition, T-K showed greater recall accuracy than K alone but this was not so in the blind group presumably due to their high dependence and sharpening of the kinesthetic mode such that additional tactile input does not augment the level of their recall accuracy. In contrast, the sighted subjects who do not primarily rely on their kinesthetic modality find in additional tactile input a ready support to improve recall accuracy. It is, therefore, not surprising to find that the blind and sighted subjects differ vastly on the constrained task based on kinesthetic input alone but not in the T-K

4.82 condition. In short, these results indicate that both preselection and bimodal presentation help in recall accuracy of the sighted people when they face visual deficit, but those who are born blind show hardly any advantage because they have already learned to encode material efficiently through their kinesthetic modality.

Another finding that shows the effectiveness of bimodal task was the significant interaction of mode x type of movement x sectors, $\underline{F}$ (1,15) = 3.87, $p < .05$. The mean values obtained are plotted in Fig. 4.4.4. The long sector in the constrained task was facilitated in the T-K mode over the K mode, the mean values being .63 cm and .98 cm, respectively. Not much difference was observed between groups on the short target which shows a uniform increase of error in preselected and constrained task for both single and bimodal presentations. The point of interest here is the difference obtained on the long target which highlights the use of bimodal information. A clear difference between the two modes is observed in the constrained type of task. It shows that longer exploratory movements are facilitated with bimodal over unimodal presentation, the mean values for T-K and K being .63 and .98, respectively. This difference is not found in the case of preselected movements possibly due to encoding plan. This point will be discussed in detail later. Also a weak

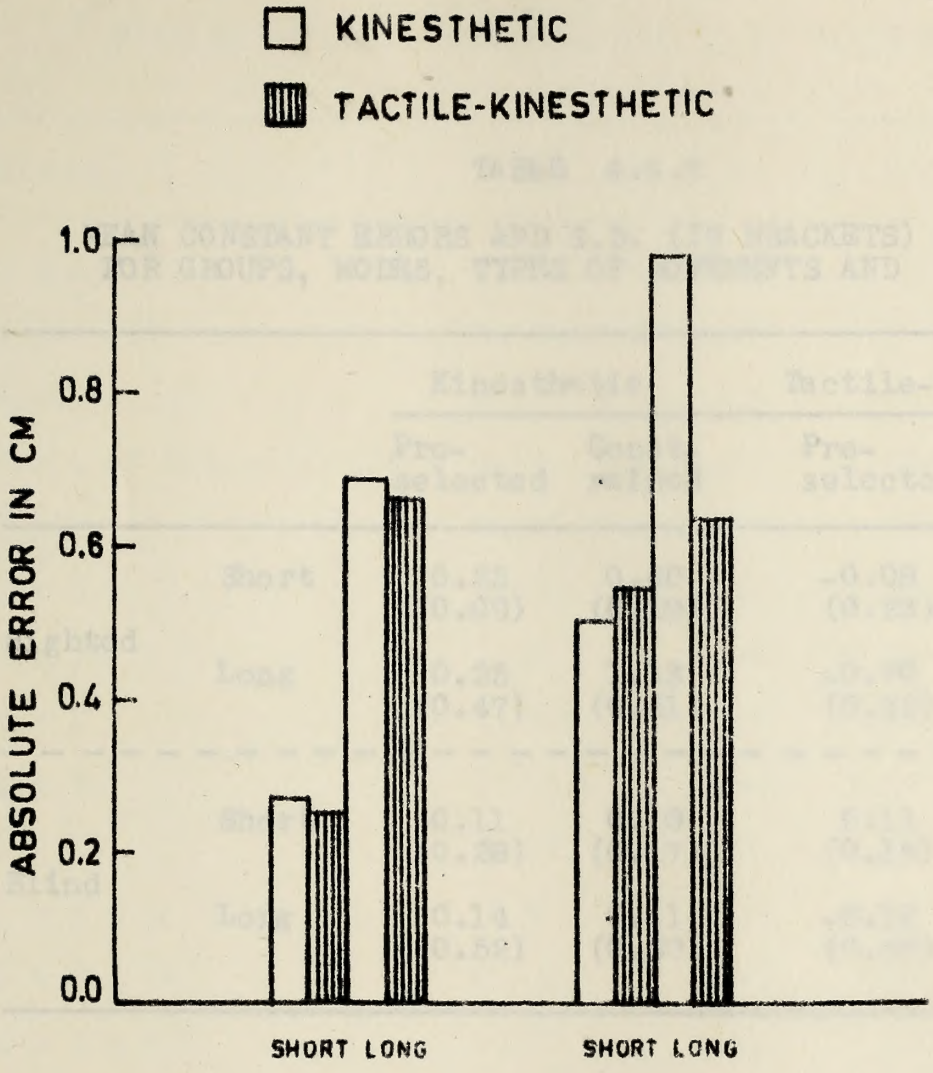


FIG.4.4.4 MEAN VALUES FOR SHORT AND LONG TARGETS IN PRESELECTED AND CONSTRAINED TASKS FOR KINESTHETIC, TACTILE-KINESTHETIC MODE

FIG.4.4.4 MEAN VALUES FOR SHORT AND LONG
TARGETS IN PRESELECTED AND
CONSTRAINED TASKS FOR KINESTHETIC,
TACTILE-KINESTHETIC MODE

4.83

TABLE 4.4.3

MEAN CONSTANT ERRORS AND S.D. (IN BRACKETS) OBTAINED FOR GROUPS, MODES, TYPES OF MOVEMENTS AND SECTORS

		Kinesthetic		Tactile-Kinesthetic	
		Pre-selected	Const-rained	Pre-selected	Const-rained
Sighted	Short	0.25 (0.09)	0.40 (0.19)	-0.08 (0.23)	0.49 (0.19)
	Long	0.25 (0.47)	1.13 (0.51)	-0.70 (0.32)	0.60 (0.25)
Blind	Short	0.11 (0.28)	0.10 (0.17)	0.11 (0.15)	0.55 0.26)
	Long	0.14 (0.52)	0.41 (0.50)	-0.12 (0.53)	-0.10 (0.43)

4.84

TABLE 4.4.4

SUMMARY OF ANOVA OBTAINED FOR CE IN EXPERIMENT 4.4

Source	Ss	df	Ms	F	P
Groups (G)	0.37	1	0.37	3.09	
Modes (M)	1.19	1	1,19	9.80	0.00
Sectors (S)	0.03	1	0.03	0.25	-
Types of Movement (TM)	3.78	1	3.78	31.20	0.00
G x M	0.58	1	0.58	4.76	0.03
G x S	0.17	1	0.17	1.38	-
G x TM	1.36	1	1.36	11.21	0.00
M x S	1.76	1	1.76	14.55	0.00
M x TM	0.32	1	0.32	2.62	-
S x TM	0.50	1	0.50	4.14	0.05
G x M x S	0.00	1	0.00	0.00	-
G x M x TM	0.12	1	0.12	0.97	-
G x S x TM	0.74	1	0.74	6.08	0.01
M x S x TM	0.15	1	0.15	1.20	-
G x M x S x TM	0.15	1	0.15	1.20	
Within groups	7.14	59	0.12		

4.85 but consistently good performance is observed in short targets for both sighted and blind subjects in the preselected target. This may be due to some non-visual cue which is applicable only in short distances.

Algebraic Errors. The CE values for mean and S.D. obtained in this experiment are presented in Table 4.4.3.

These errors show opposite direction of shooting - positive or negative - in the two modes of information. As the variations are quite distinct analysis of variance computed brought out significant independent and interacting effects. Table 4.4.4 shows the summary of ANOVA for CE in this experiment.

Main effect of groups does not reach acceptable level of significance. The variable of modes is highly significant, $\underline{F}$ (1,15) = 9.80, $p < .00$, showing different biasing effects with the two modes in recall. The third main variable of type of movement is also highly significant, $\underline{F}$ (1,15) = 31.20, $p < .00$, proving that these two types of movements are different in terms of directionality of response. Sector as a main variable is not significant. Amongst first-order interaction effects, groups x modes is statistically significant, $\underline{F}$ (1,15) = 4.76, $p < .03$. This finding (Table 4.4.5) shows that the sighted subjects tend to overshoot their targets by a great magnitude when dependent on kinesthetic memory alone.

4.86

TABLE 4.4.5

MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS ON KINESTHETIC AND TACTILE-KINESTHETIC TASKS

	Sighted	Blind
Kinesthetic	+ 2.16	+ 0.40
Tactual-Kinesthetic	+ 0.90	+ 0.52

TABLE 4.4.6

MEAN CONSTANT ERRORS OF SIGHTED AND BLIND SUBJECTS ON PRESELECTED AND CONSTRAINED TYPE OF MOVEMENT

	Sighted	Blind
Preselected	- 0.28	+ 0.29
Constrained	+ 2.82	+ 0.67

TABLE 4.4.7

MEAN CONSTANT ERRORS OF SHORT AND LONG TARGETS IN KINESTHETIC AND TACTILE-KINESTHETIC MODES

	Kinesthetic	Tactile-Kinesthetic
Short	+ 0.41	+ 0.53
Long	+ 0.95	- 0.16

4.87 Another significant interaction is that of groups x types of movement, F (1,15) = 11.21, $p < .00$. A strong tendency of overshooting in the constrained task by the sighted group was recorded as against their tendency to undershoot in the preselected task. The blind group recorded overestimation of targets in both constrained and preselected tasks. These results show that prior information about a response affects the directionality of error in recall but when it is not used, as in the case with blind subjects, the pattern of errors in recall differs (see Table 4.4.6).

First order interaction of sectors x modes is highly significant, F (1,15) = 14.56, $p < .00$. Mean values show negative errors for long targets in tactile-kinesthetic task, while in the kinesthetic task errors are in a positive direction (Table 4.4.7). No such clear effect was available for short targets.

Sectors x modes is also highly significant, F (1,15) = 14.56, $p < .00$. Mean values obtained here show negative errors for long targets in T-K task but in K they are in the positive direction. Short targets in both T-K and K show overshooting. Another significant interaction is that of sectors x types of movement, F (1,15) = 4.124, $p < .04$. Mean scores show negative errors at long targets in the preselected condition, while other conditions are positively

4.88 deviated. These results are consistent with our earlier results reported in the previous chapter and in the other research findings (Pepper and Herman, 1970; Laabs, 1973).

It is observed that second-order interaction effect of groups x types of movement x sectors is highly significant, F (1,15) = 6.079, $p < .01$. Figure 4.4.5 shows this effect. As found in the groups x modes interaction earlier, here also similar trends are observed, with the exception of target effects. The two groups do not recall short and long targets in the same direction for the preselected and constrained conditions. Whereas the blind subjects overshot all short and long targets irrespective of the nature of information - constrained or preselected, the sighted subjects undershot long targets in the preselected condition but overshoot in constrained condition. It should be noted here, particularly in comparison to the earlier results reported in the previous chapter, that the long targets are undershot by both blind and sighted subjects in all cases. The fact that long targets in this experiment are actually short, i.e. 8-10 cm, than those called short in the experiments reported in the previous chapter, i.e. shortest being 10 cm, clearly shows how the cognitive strategy in encoding the movement length has affected the responses of the blind and sighted subjects. When the sighted subjects use prior information, as is found to be so in the preselected task, he is forced to plan his response

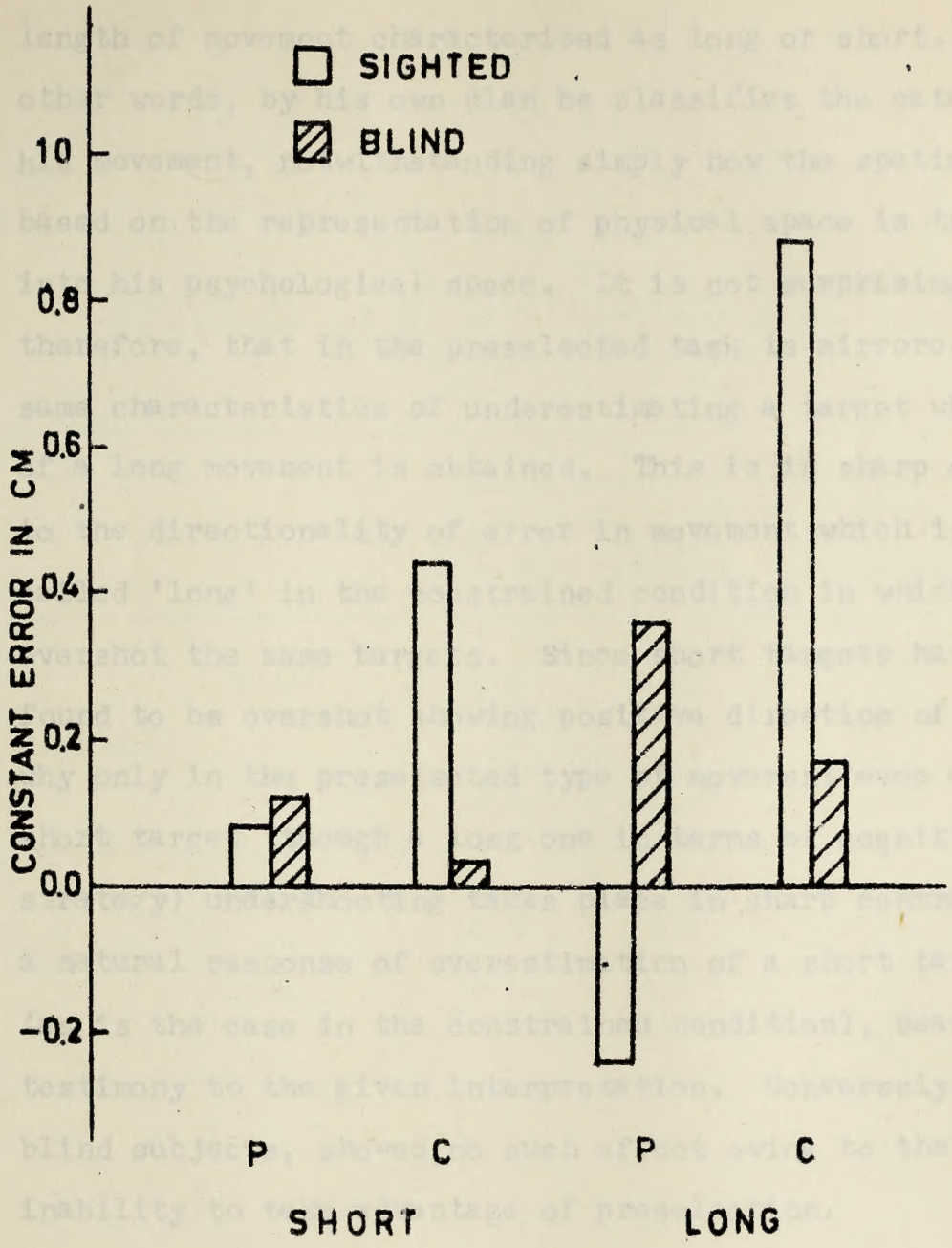


FIG.4.4.5 CONSTANT ERRORS OF SUBJECTS ON PRESELECTED AND CONSTRAINED MOVEMENT FOR THE TWO SECTORS

FIG.4.4.5 CONSTANT ERRORS OF SUBJECTS ON PRESELECTED AND CONSTRAINED MOVEMENT FOR THE TWO SECTORS

4.89 in terms of his own choice resulting in adaptation to total length of movement characterised as long or short. In other words, by his own plan he classifies the category of his movement, notwithstanding simply how the spatial image based on the representation of physical space is translated into his psychological space. It is not surprising, therefore, that in the preselected task is mirrored the same characteristics of underestimating a target when recall of a long movement is obtained. This is in sharp contrast to the directionality of error in movement which is so called 'long' in the constrained condition in which they overshot the same targets. Since short targets have been found to be overshot showing positive direction of error, why only in the preselected type of movement even at a short target (though a long one in terms of cognitive strategy) undershooting takes place in sharp contrast to a natural response of overestimation of a short target (as is the case in the constrained condition), bears a testimony to the given interpretation. Conversely, the blind subjects, showed no such effect owing to their inability to take advantage of preselection.

Movement Time. Another response recorded in this experiment was the amount of time taken in recall from the starting point to that of the assumed criterion point. Mean differences obtained here are presented in a tabular form (Table 4.4.5) to show how fluctuations have invigourated with increase in target length.

TABLE 4.4.5

MEAN AND S.D. (IN BRACKETS) VALUES FOR MOVEMENT TIME OF SIGHTED AND BLIND SUBJECTS FOR MODES, TYPES OF MOVEMENTS AND SECTORS

		Kinesthetic		Tactile-Kinesthetic	
		Pre-selected	Const-rained	Pre-selected	Const-rained
Sighted	Short	2.41 (0.68)	1.86 (1.01)	2.56 0.87)	2.22 (0.93)
	Long	5.12 (2.97)	3.81 (2.37)	3.45 (0.76)	4.56 (1.86)
Blind	Short	1.61 (0.49)	2.60 (0.37)	1.98 (0.36)	2.16 (0.87)
	Long	2.19 (0.79)	2.5 (0.95)	3.6 (1.50)	2.96 (0.78)

4.91

TABLE 4.4.6

SUMMARY OF ANOVA OBTAINED FOR MT IN EXPERIMENT 4.4

Source	Ss	df	Ms	F	P
Groups (G)	11.48	1	11.48	7.51	.00
Modes (M)	0.50	1	0.50	0.33	
Sectors (S)	34.24	1	34.24	22.41	.00
Types of Movement (TM)	0.01	1	0.01	0.01	
G x M	1.30	1	1.30	0.85	
G x S	6.92	1	6.92	4.53	.04
G x TM	1.18	1	1.18	0.77	
M x S	0.06	1	0.06	0.04	
M x TM	0.18	1	0.18	0.12	
S x TM	0.16	1	0.16	0.10	
G x M x S	3.16	1	3.16	2.06	
G x M x TM	5.75	1	5.75	3.76	.06
G x S x TM	1.28	1	1.28	0.84	
M x S x TM	1.15	1	1.15	0.75	
G x M x S x TM	1.70	1	1.70	1.11	
Within groups	90.16	59	1.53		

4.92 Analysis of variance computed (Table 4.4.6) for the above mentioned data show main variable of groups to be statistically significant, $\underline{F}$ (1,15) = 7.15, $p < .00$. Mean values obtained for recall time are 3.16 and 2.45 sec for sighted and blind subjects, respectively. This suggests faster performance by the blind group as compared to the sighted groups.

Independent variable of modes and types of movement do not show significant effects, but the variable of sector is highly significant, $\underline{F}$ (1,15) = 22.41, $p < .00$, obviously because time to reach a long target is higher than that of a short one.

Analysis of interaction effects reveals only one clear effect consisting of groups x sectors, $\underline{F}$ (1,15) = 4.53, $p < .04$ (Figure 4.4.6). It shows that the sighted group takes more time to recall a long target in contrast to the blind group, though both groups do not differ on short targets. The mean recall time for the sighted group being 4.24 sec for long targets and 2.26 sec for short targets, while for the blind group it is 2.08 sec for short and 2.83 sec for long targets, respectively. The main point of interest here is not the difference between recall time at short and long targets observed in both groups but the longer time taken by the sighted group than their blind counterparts as the length of target increased. This

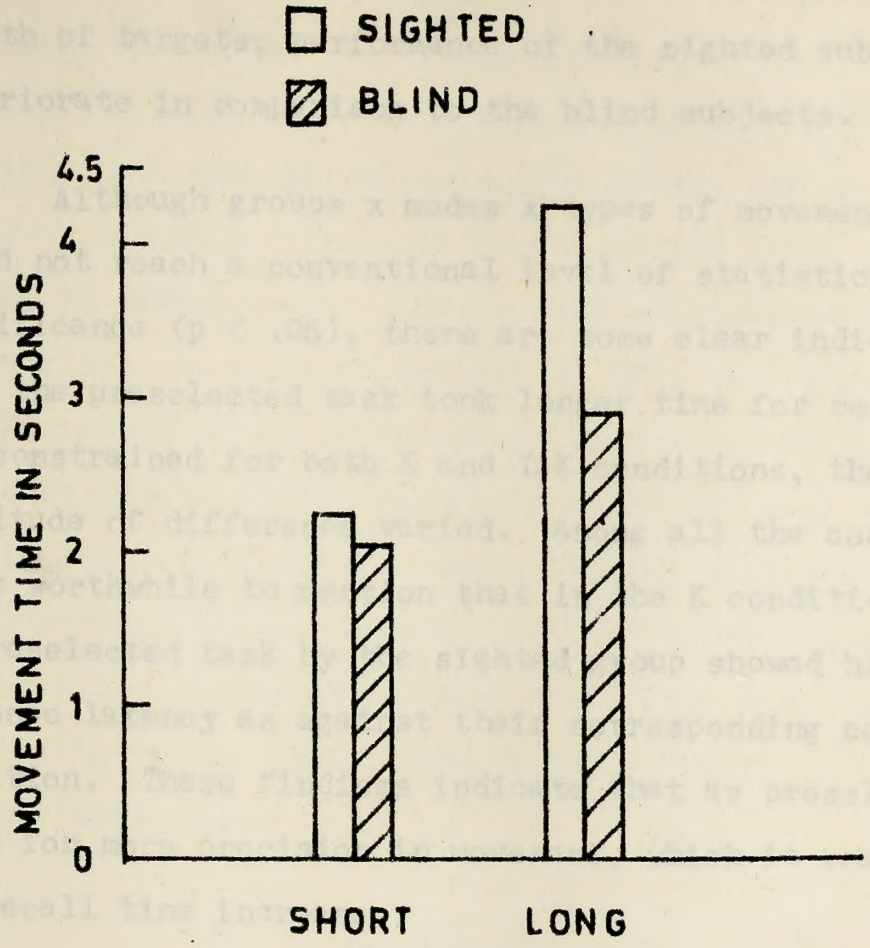


FIG.4.4.6 MOMENT TIME TAKEN BY BLIND/ SIGHTED SUBJECTS ON SHORT AND LONG TARGETS

FIG.4.4.8 MOMENT TIME TAKEN BY BLIND/
SIGHTED SUBJECTS ON SHORT
AND LONG TARGETS

4.93 confirms our explanation offered earlier that, as the response becomes feedback dependent with increase in the length of targets, performance of the sighted subjects deteriorate in comparison to the blind subjects.

Although groups x modes x types of movement effect could not reach a conventional level of statistical significance ($p < .06$), there are some clear indications that the preselected task took longer time for recall than the constrained for both K and T-K conditions, though the magnitude of difference varied. Among all the comparisons it is worthwhile to mention that in the K condition recall of preselected task by the sighted group showed highest response latency as against their corresponding constrained condition. These findings indicate that as preselection calls for more precision in movement, which it really does, the recall time increases.

To sum up, the following major findings have been reported in this experiment. First bimodal presentation like T-K helps recall of a constrained task by the sighted group but not the blind who already sharpen their kinesthetic modality to deal with movement information. Another advantage of T-K is that when the length of the target increases in the constrained condition, recall accuracy improves. Of course, preselection also helps recall accuracy but the two together do not provide any special advantage, presumably

4.94 because the representing spatial layout reaches an asymptote level beyond which almost any further amount of accuracy is difficult to elicit. Second, prior information about a movement facilitates plan to recall a target because it defines, in a typical psychological sense, far or near location or end point of the recall target which normally may not be thought out to be so in a constrained situation. A very clear evidence in support of this was found in the directionality of error of the sighted subjects who tended to underestimate short (but manipulated as long) targets much in contrast to their overestimation tendency for the same length of tasks. Lastly, the difference in movement time of blind and sighted subjects at long targets indicates superiority of the former when response tends to become feedback dependent.

EXPERIMENT 4.5

Although it is generally believed that touch and kinesthesis become better developed in the blind children as they grow to cope up with the environmental demands, the evidence collected from the previous experiment clearly indicates that the overall performance of both blind and sighted groups in recalling target positions based on their kinesthetic and tactile inputs were not different. In fact, the data tended to show that it was the sighted group who drew more benefit than the blind group. Even in

4.95 response parameter of movement time, tactile-kinesthetic input wiped out the difference between the blind and sighted groups which was quite evident in so far as kinesthetic input alone was concerned.

Earlier, in the first three experiments (Section I) an attempt was made to examine the effects of modality specific distractors (tactual) and attention demanding activity (verbal). The findings unequivocally proved that these distractors do not affect the performance of blind and sighted subjects identically. Given that the blind subjects are adversely affected by tactually interpolated task and the sighted subjects by verbally interpolated activity, it is reasonable to assume that the processing of information in these two groups is dominated by different modalities. However, these findings were confined to the examination of recognition of shapes in the blind and sighted subjects. It remains to be seen how the attention demanding and structural distractors would affect the estimation of length. It was reported earlier that blind children are generally found superior than their sighted counterparts in size and shape judgements (Yarmolenko, 1957). But then, it has already been shown in the present work that such a generalization is restricted by the demands involved in a task. Another argument along the same lines is that the support of tactile and kinesthetic inputs in the coding mechanism are not unlimited; for the overall

4.96 conclusions based on Experiment 4.4 is that the sighted subjects seek advantage of tactile input but not the blind - at least to the same extent as the sighted do.

It seems that a lot of controversy regarding superiority of vision and movement organization or vice versa is due to lack of appreciation of the nuances of the type explained in foregoing paragraphs. It is true that the nature of interdependence of sensory modalities changes with age. For example, Jones (1972) reported that tactile method was superior for localization upto the age of 12 years, but it could not match vision presumably because sighted children mainly depend on it. In contrast, as Jones (1975) remarked, 'blind may develop, rather more quickly than the sighted, skills which normally speaking involve more accurate perception of events within the child's own body space or the perception of movements of his body within a predetermined space' (p. 469).

Of course, all this is still a matter of conjecture. As Jones himself writes, "Unfortunately, there is as yet not clear cut evidence on the development of tactual perception in the blind, and well-controlled comparisons of the blind and the sighted would be useful. On the other hand, tactual perception may be more accurate in blind adults, implying that the link between body space and the world is voluntary movement. By acquiring more

4.97 efficient patterns of voluntary movement the blind person acquires more accurate perceptions of things in the world" (ibid, pp. 469-470). And yet it is surprising to note that in very simple tasks like the one involving preselection in the previous experiment, the blind group failed to take advantage of their own prior information. In other words, it is contended here that deficit of representation of spatial layout in the blind people need not be oversimplified.

In the previous experiment it was noted that bimodal presentation is superior to unimodal presentation in both blind and sighted subjects, which means that sensory enrichment improves their performance and counterbalances relative advantages and disadvantages accruing out of use or disuse of sensory modes. Since results of Experiments 4.1, 4.2 and 4.3 clearly indicate that movement and verbal distractors adversely affected the performance of the blind and the sighted groups, respectively, it remains to be seen how the effect of these distractors are attenuated in situations in which an opportunity for sensory enrichment is provided. To be more specific, it may be proposed that with bimodal presentation the effect of distractors would not cause difference between the sighted and blind groups to the same magnitude as was recorded with unimodal presentation.

4.98 It is further hypothesised that the effects of preselection would be characteristically available in all the distractor conditions (UD, VD or TD), as had been the case with forward and backward biasing effects (Experiment No.3.9, in previous chapter). In other words, it is expected that undershooting of long targets would take place in a preselected task involving unfilled, verbal or tactile distractor.

Owing to sensitivity of responses of blind and sighted subjects, as have been observed in several experiments reported here, with respect to their length of response, prior activities or location of targets it is imperative to verify the aforesaid previous results. If the advantage of preselection is mainly observed in the sighted group it should also come out distinctly in the integrated input situation like the one proposed in this experiment, specially when distractors tend to retard performance.

Although movement time of blind subjects was shorter than those of sighted subjects for long targets in the kinesthetic conditions of the previous experiment, no such difference was found in the T-K condition. It should be noted here that the recall in the previous experiment was demanded immediately after the standard movement. However, it is proposed in this experiment that with delay in recall

4.99 the blind subjects would perform better than the sighted, specially when distractors are introduced in T-K condition.

It may be recalled that in the shape recognition task in Experiment 4.2, verbal distractor increased latency of response of the sighted more than the blind subjects, while tactual distractor task was more harmful to the blind than those in the sighted group. In the present experiment it is hypothesized that the effect of verbal distractor will be iddentical to Experiment 4.2, i.e. more harmful to the sighted than the blind. But unlike the earlier results showing adverse effects of tactual distractors on the blind group as compared to the sighted, the effect of bimodal presentation would help the blind to give superior performance than their counterparts in the sighted group even with tactile distractors. In other words, it means that when distractors are modality specific and encoding is not supported from any other modality, blind subjects show greater loss in their recall; given an opportunity to integrate information from additional source, they improve their performance and can attenuate the impeding effects arising out of distractors within the same modality.

Method and Procedure

Sample. A total of 111 adult subjects (56 sighted and 55 blind) were selected to participate in this experiment.

4.100 Apparatus and Materials. This was same as used in Experiment 4.4.

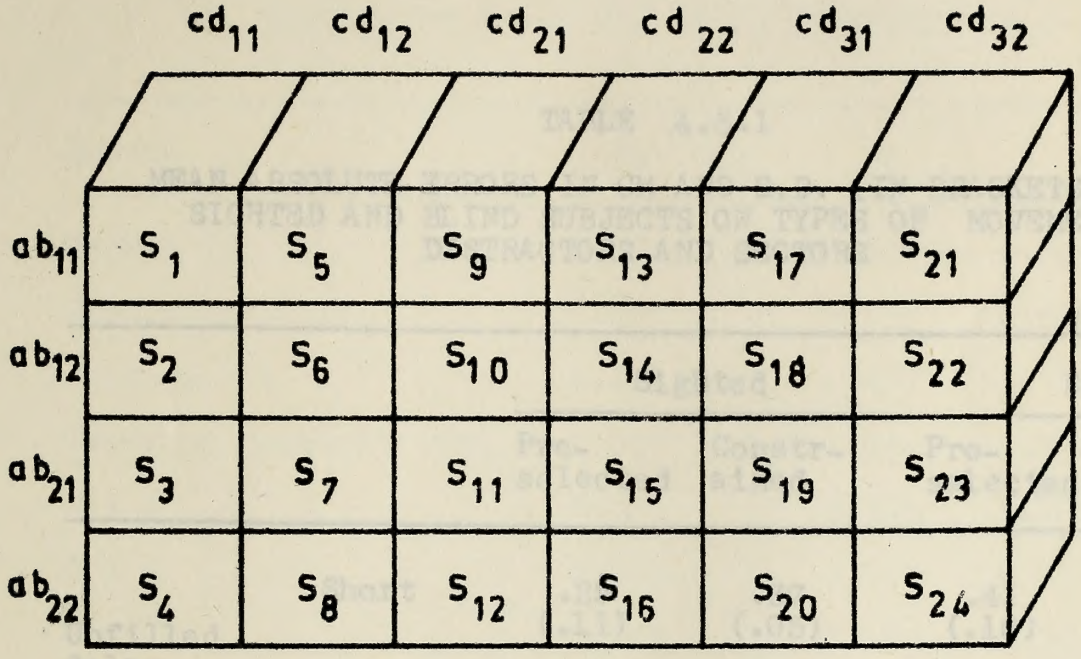
Experimental Design and Procedure. A 4-way 2 x 2 x 3 x 2 between subject (unequal cell) design having groups (sighted or blind), types of movement (preselected or constrained), interpolated activities (unfilled delay (UD), verbal distractor (VD) or tactile kinesthetic distractor (TD)) and sectors (short or long) was utilized (Figure 4.5.1) for this purpose. Appendix 4.V shows the raw data obtained in this experiment.

Unfilled delay and verbal distractor tasks were similar as in other experiments. The only difference was in the tactile distractor task, where subjects stimulated their forearm during the delay period.

Dependent variables. Same as in previous experiment.

Results and Discussion

Absolute Errors. Mean AE values under different conditions were calculated for this experiment and are presented in Table 4.5.1. For the purpose of analysis, the data were subjected to statistical treatment of ANOVA, a summary of which is presented in Table 4.5.2.



a) GROUP b) TYPE OF MOVEMENT c) DISTRACTORS

1) SIGHTED 1) PRESELECTED 1) UNFILLED DELAY

2) BLIND 2) CONSTRAINED 2) VERBAL DISTRACTOR

3) T — K DISTRACTOR

d) SECTORS

1) SHORT (0-2cm)

2) LONG (8-10cm)

N=111 (55 BLIND /56 SIGHTED)

FIG.4.5.1 DESIGN FOR EXPERIMENT 4.5

cd11
cd12
cd21
cd22
cd31
cd32
ab11
ab12
ab21
ab22
S1
S5
S9
S13
S17
S21
S2
S6
S10
S14
S18
S22
S3
S7
S11
S15
S19
S23
S4
S8
S12
S16
S20
S24

4.101

TABLE 4.5.1

MEAN ABSOLUTE ERRORS IN CM AND S.D. (IN BRACKETS) OF SIGHTED AND BLIND SUBJECTS ON TYPES OF MOVEMENT, DISTRACTORS AND SECTORS

		Sighted		Blind	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
Unfilled delay	Short	.25 (.11)	.37 (.05)	.41 (.16)	.41 (.20)
	Long	.42 (.12)	1.02 (.19)	.71 (.31)	.96 (.28)
Verbal distractor	Short	.31 (.12)	.49 (.13)	.31 (.06)	.40 (.16)
	Long	.84 (.35)	1.23 (.61)	.74 (.24)	.71 (.39)
Tactile distractor	Short	.36 (.35)	.61 (.47)	.26 (.12)	.47 (.25)
	Long	.56 (.35)	.66 (.25)	.69 (.37)	.90 (.27)

4.102

TABLE 4.5.2

SUMMARY OF ANOVA FOR AE IN EXPERIMENT 4.V

Source	Ss	df	Ms	F	p
Groups (G)	0.004	1	0.004	0.060	
Distractors (D)	0.099	2	0.049	0.692	
Sectors (S)	4.410	1	4.410	61.744	0.00
Types of Movement (TM)	1.059	1	1.059	14.826	0.00
G x C	0.401	2	0.201	2.808	0.06
G x S	0.002	1	0.002	0.033	
G x TM	0.165	1	0.165	2.306	
D x S	0.225	2	0.113	1.578	
D x TM	0.033	2	0.16	0.230	
S x TM	0.085	1	0.085	1.190	
G x D x S	0.357	2	0.178	2.496	0.09
G x D x TM	0.116	2	0.058	0.814	
G x S x TM	0.036	1	0.036	0.507	
D x S x TM	0.232	2	0.116	1.626	
G x D x S x TM	0.075	2	0.037	0.525	
Within group	6.215	87	0.071		

4.103 Main variable of group is not significant and confirms previous findings. This shows that the overall performance of blind and sighted subjects are similar for absolute error analysis. Preselection as a main variable is highly significant, F (1,23) = 14.83, $p < .00$. The variable of sector is also highly significant, F (1,23) = 61.74, $p < .00$. Distractors as a main effect is not significant.

First-order interaction of groups with distractors is impressive but not significant to a conventional level of significance, F (2,23) = 2.81, $p < .06$. Therefore only a weak support to the hypothesis that groups perform differently on various distractors may be drawn for this T-K task. In other words, integrated mode tends to reduce the effect of distractors but the data of this experiment show that it could not nullify the total effect because both blind and sighted groups were affected more by the tactile and verbal distractors, respectively, than their counterparts, at least to some appreciable extent and along the same trend which was observed in earlier experiments.

Probably the same is true for the second order interaction effect of groups x distractors x sectors which fell below .05 level of significance, F (2,23) = 2.50, $p < .09$, and give only a marginal support to the hypothesis that the effect of distractors would differ for the performance of blind and sighted subjects at short and long sectors.

.104 A separate analysis of various sets of data in this experiment based on computation of t-tests showed that a verbal distraction task is more harmful for the sighted than the blind group, $t = 4.00$, $(df = 7)$, $p < .01$, while a tactile distractor has affected the blind subjects more than the sighted, $t = 4.8$ $(df = 7)$, $p < .01$. These findings are similar to those obtained in the previous section of this chapter. A point to be emphasized here is that such effects are clear only in the case of a long constrained movements. In consonance with the findings of Experiment 4.4, it may be concluded that among the sighted people, a preselected task does not leave enough margin for improving recall accuracy so that a difference between bimodal and unimodal tasks could be demonstrated. Further preselection tends to reduce the effect of interpolated tasks which were found to be harmful to the performance in earlier experiments.

Constant Errors. Table 4.5.3 shows the means and S.D. of errors obtained in the algebraic error analysis. These are further subjected to an analysis of variance test a summary of which is presented in Table 4.5.4. As found in Experiment 4.4, main variable of groups is statistically significant, $F (1,23) = 5.02$, $p < .02$. Mean errors obtained here are +0.02 cm and +0.19 cm for the sighted and blind subjects, respectively. Similar to results found in absolute error analysis, constant error does not show independent effect of distractors. Main effect of types of

.105

TABLE 4.5.3

MEAN CONSTANT ERRORS (IN CM) AND S.D. (IN BRACKETS) OF BLIND AND SIGHTED SUBJECTS ON TYPE OF MOVEMENT, CONDITIONS AND SECTORS

		Sighted		Blinds	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
Unfilled delay	Short	0.72 (.15)	.76 (.15)	.70 (.18)	1.58 (.31)
	Long	-1.36 (-0.27)	1.22 (.24)	-2-28 (-.46)	2.70 (.54)
Verbal distractor	Short	-0.20 (-0.40)	0.48 (0.10)	-0.82 (.16)	1.36 (.34)
	Long	-1.54 (-0.39)	2.96 (0.59)	0.92 (.18)	.70 (.18)
Tactual distractor	Short	0.26 (.07)	1.58 (.40)	0.02 (.004)	2.02 (.40)
	Long	-1.86 (-0.47)	-1.78 (-.36)	-0.60 (-.15)	2.68 (.67)

4.106

TABLE 4.5.4

SUMMARY OF ANOVA FOR CE IN EXPERIMENT 4.5

Source	Ss	Df	Ms	F	p
Groups (G)	0.919	1	0.99	5.018	0.028
Distractors (D)	0.087	2	0.043	0.237	
Sectors (S)	0.683	2	0.683	3.733	.057
Types of Movement (TM)	4.03	1	4.03	22.019	.000
G x D	0.287	2	0.143	0.783	
G x S	0.196	1	0.196	1.070	
G x TM	0.038	1	0.038	0.209	
D x S	0.394	2	0.197	1.007	
D x TM	0.055	2	0.028	0.150	
S x TM	0.937	1	0.937	5.119	.03
G x D x S	0.937	2	0.469	2.561	.08
G x D x TM	1.032	2	0.516	2.818	.06
G x S x TM	0.000	1	0.000	0.002	
D x S x TM	0.397	2	0.198	1.084	
G x D x S x TM	0.896	2	0.448	2.448	0.09
Within groups	15.924	87	0.183		

4.107 movement is highly significant, $\underline{F}$ (1,23) = 22.02, $p < .00$. Sectors effect is also statistically significant, $\underline{F}$ (1,23) = 3.73, $p < .05$.

Significant first-order interaction effect is found between sectors x types of movement, $\underline{F}$ (1,23) = 5.13, $p < .03$. The mean values obtained here show that the variations obtained between preselected and constrained tasks are quite similar for short targets, the mean values being + 0.85 cm and + 0.77 cm, respectively, but for long sectors differences are quite large, i.e. -0.86 cm for preselected and -0.01 cm for constrained task.

Two second-order interaction effects have been found to be positive though not significant at the conventional levels. Groups x distractors x sectors effect, $\underline{F}$ (2,23) = 2.56, $p < .08$, shows that the error trend is diverse mainly in the case of long sector in the tactual distractor task on which the sighted group underestimated but the blind group overestimated. Besides this, the errors in the short sector are in the positive direction, while they are in the negative direction at long sector. Groups x distractors x types of movement interaction, $\underline{F}$ (2,23) = 2.81, $p < .06$, shows that recall errors in all the preselected conditions show underestimation by the sighted group, while constrained condition reveals predominantly positive errors by the blind group. Again, it should be noted here that the effects of

4.108 bimodal presentation seem to have helped both the blind and sighted subjects to overcome the deficits caused by the distractors and hence this weak effect. Analysis of various sets of data separately based on application of t tests showed that direction of estimation differed in the recall of preselected and constrained movement for the sighted subjects and confirm our earlier results, i.e. underestimation in long preselected tasks and overestimation in long constrained task. Separate analysis of unfilled delay and verbal distractor tasks revealed that this effect was found in both distractor conditions, i.e. for UD, $t = 4.76$ ($df = 8$), $p < .01$, and for VD, $t = 10.92$, ($df = 8$), $p < .01$. However, this was not so with the tactile distractor task.

Movement Time. Data on movement time were analysed to find out the differences between the two groups. Mean values obtained in the analysis are presented in Table 4.5.5. Further, analysis of variance test was computed and its results are presented in Table 4.5.6.

Main effect of groups is highly significant, $F (1,23) = 11.00$, $p < .00$, which shows that latency period of the blind groups was considerably lower than those in the sighted, this being 4.07 sec and 3.07 sec for the sighted and blind subjects, respectively. This is consistent with the results of the earlier experiment showing faster response latencies by the blind group.

TABLE 4.5.5

MEAN AND S.D. VALUES (IN BRACKETS) OF MOVEMENT TIME FOR SIGHTED AND BLIND SUBJECTS, DISTRACTORS, TYPES OF MOVEMENT AND SECTORS

		Sighted		Blinds	
		Pre-selected	Constr-ained	Pre-selected	Constr-ained
Unfilled delay	Short	2.45 (.93)	2.46 (.59)	1.85 (.72)	1.43 (.20)
	Long	5.20 (1.92)	4.14 (1.39)	3.93 (1.80)	4.70 (2.87)
Verbal distractor	Short	2.82 (1.37)	2.38 (0.86)	1.76 (.79)	2.24 (0.96)
	Long	7.29 (2.69)	6.45 (2.06)	4.93 (2.23)	5.82 (1.97)
Tactual distractor	Short	2.21 (1.06)	4.27 (1.29)	1.94 (0.63)	2.27 (1.05)
	Long	3.58 (1.25)	5.86 (2.31)	3.09 (2.07)	3.14 (1.27)

.110

TABLE 4.5.6

SUMMARY OF ANOVA FOR MT IN EXPERIMENT 4.5

Source	Ss	Df	Ms	F	p
Groups (G)	27.634	1	27.634	10.998	0.00
Distractors (D)	21.135	2	10.567	4.206	0.01
Sectors (S)	171.667	1	171.667	68.325	0.00
Types of Movement (TM)	3.210	1	3.210	1.277	
G x D	2.840	2	1.420	0.565	
G x S	0.650	1	0.650	0.259	
G x TM	0.002	1	0.002	0.001	
D x S	29.550	2	14.775	5.880	0.00
D x TM	9.589	2	4.795	1.908	
S x TM	0.002	1	0.002	0.001	
G x D x S	2.223	2	1.11	0.442	
G x D x TM	13.622	2	6.811	2.711	0.07
G x S x TM	1.283	1	1.283	0.511	
D x S x TM	0.009	2	0.005	0.002	
G x D x S x TM	2.190	2	1.095	0.436	
Within groups	218.59	87	2.513		

4.111 Distractors as a main effect is highly significant, $\underline{F}$ (2,23) = 4.21, $p < .01$. It shows that reproduction of movement consumes highest time when interpolation is verbal. The mean latencies obtained here are 3.30, 3.86 and 3.32 for unfilled delay, verbal distractor and tactile distractor, respectively. This finding is important in the light of the fact that significant effects were not found in the AE and CE error analyses.

The effect of sectors is obviously highly significant, $\underline{F}$ (1,23) = 68.3.3, $p < .00$, because short and long targets obviously do not take equal time for movement. Type of movement as a main effect is not significant, similar to the findings of the previous experiments.

Amongst first-order interactions, the only significant one is distractors x sectors, $\underline{F}$ (2,23) = 5.88, $p < .00$. The mean values plotted for this interaction (Figure 4.5.2) indicates that in short sectors the effect of verbal distractor is not high but at long sector it is very substantial.

A second-order interpolation effect consisting of groups x distractors x types of movement is significant only at the .07 level of significance, $\underline{F}$ (2,23) = 2.71, $p < .07$. Therefore, only with a great deal of caution it can be remarked that the distractors show unequal effect on the blind and sighted subjects in the preselected and

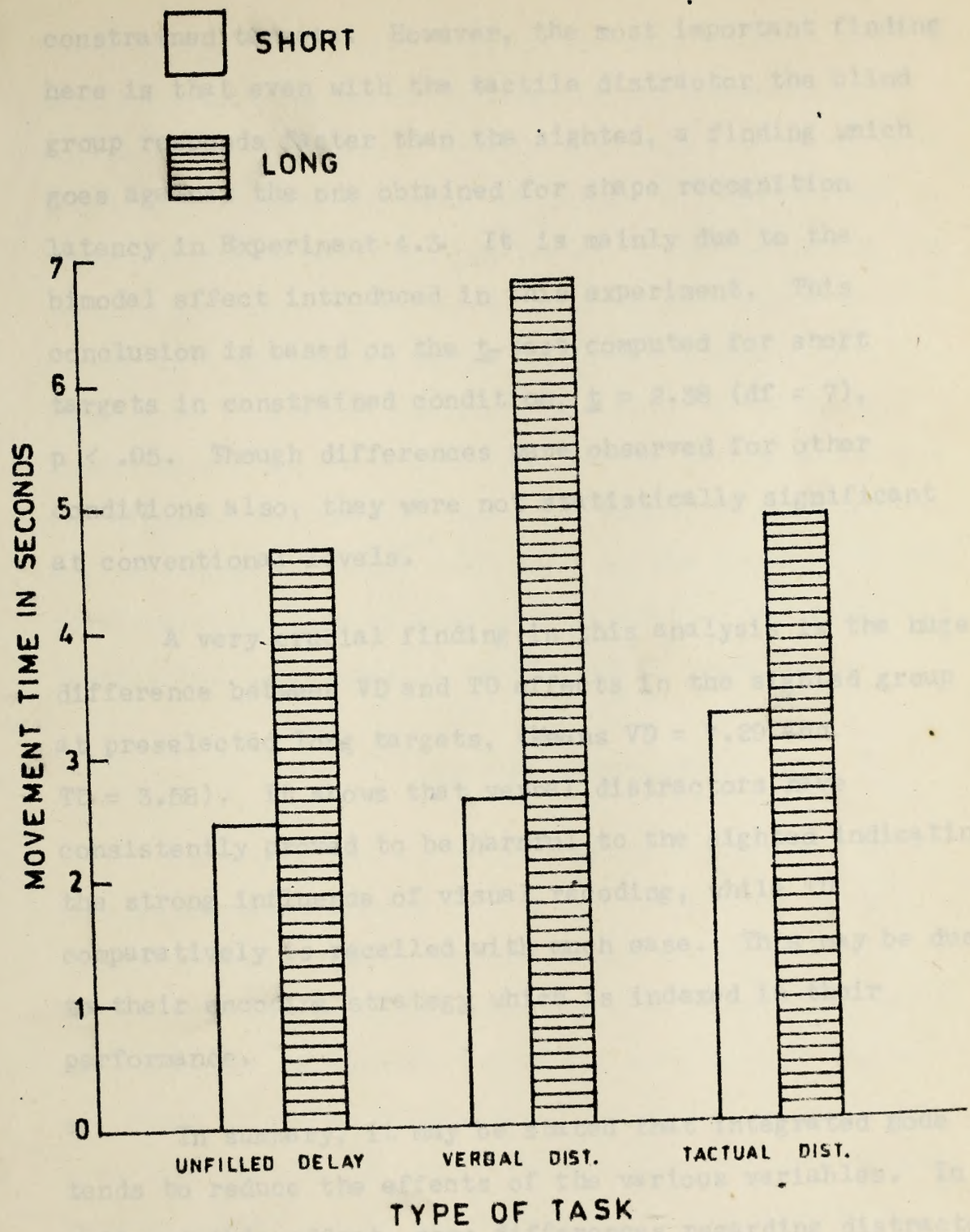


FIG.4.5.2 MEAN TIME FOR SHORT AND LONG TARGETS ON VARIOUS DISTRACTORS

FIG.4.5.2 MEAN TIME FOR SHORT AND LONG TARGETS
ON VARIOUS DISTRACTORS

4.112 constrained targets. However, the most important finding here is that even with the tactile distractor the blind group responds faster than the sighted, a finding which goes against the one obtained for shape recognition latency in Experiment 4.3. It is mainly due to the bimodal effect introduced in this experiment. This conclusion is based on the t-test computed for short targets in constrained condition, $t = 2.38$ ($df = 7$), $p < .05$. Though differences were observed for other conditions also, they were not statistically significant at conventional levels.

A very crucial finding in this analysis is the huge difference between VD and TD effects in the sighted group at preselected long targets, (Means VD = 7.29 and TD = 3.58). It shows that verbal distractors have consistently proved to be harmful to the sighted indicating the strong influence of visual recoding, while TD comparatively is recalled with much ease. This may be due to their encoding strategy which is indexed in their performance.

In summary, it may be stated that integrated mode tends to reduce the effects of the various variables. In spite of this effect, some differences regarding distractors were observed and the results are somewhat consistent, i.e. effect of verbal distractor was pronounced for the sighted group while effect of tactile distractor was seen in the

4.113 blind group. These were only in the case of long targets. Similar result for verbal distractor was observed in movement time analysis. Tactile distractor seems to have facilitated recall for both the groups in contrast to verbal distractors. This may be due to the nature of the tactile distractor task which formed multi-traces while acting as a distractor during the delay period. This holds good in view of the fact that blind subjects took lesser time than the sighted who depend mainly on tactile and kinesthetic inputs. This was evident in constant error analysis also and hence consistent to the findings of the previous study showing that underestimation was found in preselected tasks only in the UD and VD conditions.

GENERAL DISCUSSION

Investigations in verbal memory experiments have made attempts to examine recall and recognition memory (Mandler, et al, 1969), though direct comparisons are difficult. Generally speaking subjects often store much more information than what they are able to retrieve on any given trial, irrespective of the method of testing retention that is involved. Emphasizing the same point, Tulving (1968) points out that items may be available (learnt) but not accessible (retrievable). So, recognition allows the subject to take advantage of partial learning, due to which a single feature of an item may be sufficient

4.114 to allow its recognition but no such facilitation is involved in its recall. It is not surprising, therefore, that in a shape recognition task accuracy of recognition was not a primary and distinguishing feature but the latency of recognition was found to be an important source to delineate the differences between the sighted and blind groups. In the second section consisting of Experiment 4.4 and 4.5, recall accuracy was measured as also the movement time. It should be noted here that in both sections the experiments had involved touch as the main, or at least an important, source of input but the response parameters differed between the two; in the former section manual exploration of shape was involved with recognition time as the dependent variable, while in the latter the skin was stimulated on the entire forearm before recall of a target point was obtained.

From the obtained performance levels of the blind and sighted subjects in the earlier experiments it has been proved that the underlying mechanisms of coding in memory were different for the two groups when the distractors were introduced. This, however, was established for tactual shape recognition only. Experiment 4.5 provides additional support for altered coding in tactile-kinesthetic memory also. Attention demanding activity here was powerful to cause deleterious effects for the sighted subjects in accuracy as well as time. Also, a bimodal task was beneficial in subduing the differences in response of the two groups.

.115 An interesting point which merits mention here (Experiment 4.4) is that the differences obtained between a preselected and constrained task in the unimodal (kinesthetic) task are minimized in the bimodal task (tactile-kinesthetic). Thus, the disparity that was observed in the former is reduced and, in fact, neutralized in the latter. Secondly, in the long sector a bimodal response is better recalled than the unimodal response, while in the short sector both the modes of movement had similar recall scores. Therefore, facilitatory effects are observable in the bimodal task.

In addition, due to the nature of the bimodal task, preselection vs constrained task do not differ significantly in recall as was found in Experiments 4.4 and 4.5 as against the findings reported in Chapter 3 on motor memory. This means that enrichment of sensory experience by way of bimodal presentation facilitates recall in constrained condition but hardly brings any more support to preselection. This supports Kelso and Wallace's (1978) statement described earlier.

Another effect of bimodal presentation is reflected in the shift in direction of errors of recall. Clearly observable are the undershooting tendencies when touch is in liason with movement. Supporting evidence for such tendencies may be drawn from the concepts of 'proximal' and

.116 'distal' stimuli (Atteneave and Benson, 1969). The findings suggest that a tendency to respond from the 'proximity' of the body is observed when touch stimuli is given without the presence of vision; with the availability of vision, however, a tendency to respond to external objects, i.e. distal stimuli is observed (Hermelin and O'Connor 1971). This indicates that if vision is not available movement becomes restricted when in liason with touch. Another explanation in support to this comes from a study by Bartlett (1953), who found that a cylinder rolled near the head appeared to be larger than when rolled at an arm's distance, in the absence of vision. This suggests a natural tendency to reduce the actual size of an object when further away from the body. It may be deduced from this that in the present study, too, the recall of actual movement was short when the target point was farther away from the body. This is very well reflected in a tendency to underestimate targets when self-chosen.

A very significant point here is that long distances were **underestimated** when the movement was voluntary. In the case of a constrained task, this was not evident at all, a finding which falls in sharp contrast to those reported in the earlier chapter. This brings us to the fundamental question of whether long sectors were really long? As discussed elaborately in Experiment 4.4, in a preselected movement condition the entire distance is

.117 categorized and defined into various sectors before the onset of the movement. Hence, the subject tends to divide this distance in terms of psychological space, irrespective of the distance moved in physical space. It is no wonder, therefore, that underestimation tendencies are observed in preselected long sectors, as found normally with long targets. However, since no such barrier exists for the constrained task, this is recalled with a positive bias, i.e. the long distance in reality being small (10 cm), and reflects the type of errors normally characteristic of a short target as was reported for several experiments in the previous chapter. This explanation seems convincing enough in the light of the present finding.

Irrespective of the directionality of error, a preselection cue has consistently been found to show more accurate recall, when compared to a constrained type of task. In a preselected task, which utilizes a pre-planning strategy (Experiment 4.4), no advantage of bimodal information is visible which is not so in the case of unimodal information. It has already been reported in the previous chapter that forward or backward biasing has no effect in recall with preselection. Similarly, verbal and movement distractors utilized in a preselected task also could not significantly affect the performance. Such indications are also available in Experiment 4.5 of this study. All these above mentioned findings lead us to assume that organization of movements

.118 with preselection facilitate such that all other factors bear less significance. In this context the visual reference system plays an important part because the blind subjects are unable to show such type of facilitatory effect.

In short, the following conclusions are drawn from the above findings. First, preselected information has a strong central representation in memory of the sighted people, while the blind people fail to make use of it, presumably due to their lack of visual experience. Second, although a preselected task is better recalled than the constrained one, unlike in a unimodal task, the bimodal task tends to minimize the gap which indicates that integration of information helps performance. Under these conditions, the difference between the blind and sighted groups also disappear. However, bimodal task (T-K) tends to cause undershooting of responses which is opposite to the one in a unimodal condition. And third, the distractors do not have identical effects on the blind and sighted groups, the sighted groups being superior with effective use of preselection. Other findings like faster responses of the blind people, sector differences and interaction with blind and sighted groups, etc further verified the results reported in the previous chapter.

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CHAPTER 5

SHORT TERM RECALL OF VERBAL MATERIAL BY BLIND, DEAF AND HEARING PEOPLE

It has been established that with simple verbal material, such as constant sequences or common unrelated words, the predominant storage mode depends on acoustic coding (Conrad and Rush, 1965). This is very much evidenced when the errors tend to be acoustically similar to the correct item even when material is visually presented. Therefore, one can see that nature has provided us with a system wherein simple representative acoustic imagery has some prior biological advantage over other modes for sustaining memories for at least over brief periods. In such a case it is interesting to find out how children severely deaf from birth or an early age would depend on mediation by modes other than sounds. Conversely, it would be also significant to compare the performance of blind people on similar tasks as those given to the deaf, assuming that the sensory handicap would indicate the magnitude of the difference among them and throw light on modality limitations.

CHAPTER 5

SHORT TERM RECALL OF VERBAL MATERIAL BY BLIND, DEAF AND HEARING PEOPLE

.2 It is generally stated that the brain acts as a single communication channel of limited capacity in which only one high information signal can occupy the channel at any given time (Broadbent, 1958). This is commonly experienced with people's inability to perform two tasks simultaneously unless the people are very well practised or the tasks are highly dissimilar. It is also suggested that the brain acts as a limited capacity processor, analogous to a time sharing computer. Thus, two tasks may be performed together as long as they do not require more than the total amount of processing resources. In this connection modality specific resource limitations have been demonstrated. Segal and fusella (1970) found that visual signal detection is more disrupted by imagining pictures than by imagining sounds. Brooks (1968) found that speaking aloud interfered more with verbal memory than did directional pointing. Penney (1974) found that an auditory postlist cue interfered more with recall of auditorially presented words and a visual postlist cue with visually presented words. Hopkins et al (1971) showed that if, after a series of trials using one sensory modality, a shift to another modality occurred, there was for some conditions an improvement in recall and for others not, e.g. a shift to auditory presentation after 3 visual trials produced significant recovery. A detailed discussion of this problem has also been made in chapters on motor and touch memory.

.3 Several studies have been conducted in the last few years to compare the relative effects of auditory and visual modes of presentation on short term memory (STM). Murdock (1966) compared auditory and visual modes of presentation and showed a superiority for the auditory mode in recall for several seconds after presentation. Margrain (1967) showed that the short term retention of digit list was superior when presentation was auditory as opposed to visual. Using a modified free recall technique in which subjects started their recall with items from either the beginning or the end of the list, Craik (1969) found slight advantage for the auditory as compared to the visual input. While at the 0 and 3 sec retention interval, the auditory presentations yielded superior recall in Peterson and Johnson's (1971) experiment, there was a marked reversal in favour of the visual mode at the 11 sec retention interval. Using a Peterson and Peterson type of distractor technique, the results of Scarborough's experiment (1972) for a comparison between the auditory and visual modes of presentation showed better recall for visually presented trigrams after about an 18 sec recall interval.

Although auditory and visual modes have been recognised as having differential effects on recall accuracy scores of STM studies, there seems to be lack of unanimity among researchers regarding the mechanism involved in the

.4 shift showing superiority from auditory to visual mode at delayed recall intervals. Three major explanations of modality effects have been receiving support in the past few years: (A) Murdock (1972) attributed the difference between the auditory and visual modes to modality-specific stores. These stores are conceived as precategorical in the sense that they correspond to a level of analysis prior to that at which individual words are identified. (B) The second explanation lays emphasis on the recency effect which is derived from a single, short term, post-categorical memory system of primary memory (Craik, 1969; Crowder, 1970; Crowder and Morton, 1969). (C) The third category of explanation to account for the difference between modality effects is altogether different from the aforesaid viewpoints. It holds that items retained in a short term, post-categorical or primary memory are phonemically coded, and hence more compatible with auditory than visual input (Laughery and Pinkus, 1966). These viewpoints have been illustrated elsewhere (Watkins, 1972; Watkins and Watkins, 1973).

From the aforesaid description it is clear that at present there is no single compelling argument in favour of either a pre- or postcategorical explanation of the modality effect. Watkins (1972) interpreted some results concerning modality effects in short term memory as an evidence that

the locus of the modality effect is post-categorical rather than pre-categorical. However, Nilsson (1975) pointed out some limitations in Watkins work by arguing that word length alone is an insensitive and, probably, inappropriate variable for such investigation.

Crowder and Morton (1969) state that pre-categorical acoustic storage (PAS) receives information only from the ears; it is not affected by visual stimulation and is explicitly distinguished from storage in terms of articulation. They suggested that visually and auditorially presented items are briefly held in modality-specific storage system before they become semantically analysed. On the other hand, pre-categorical acoustic storage plays a substantial role in determining memory strategy for auditorially presented items. Pre-perceptual iconic storage is too brief to influence memory strategy, and in effect visual information is semantically analysed and stored in an abstract verbal memory system, probably in an articulatory form (Sperling, 1967). Crowder and Morton (1969) investigated the influence of input modality on short term memory mainly in terms of stimulus suffix and response prefix effects or in terms of cross-modal recognition memory (Kirsner and Craik, 1971). However, there may be other aspects of short term memory in which the organization of visual material could be affected by the presence or absence of an intact auditory or articulatory system. They also found that primacy effects

occurred with both visually and auditorially presented items. They concluded that these recency effects occurred in a 'pre-categorical acoustic store'. Primacy effects, on the other hand, are attributed to the fact that items occurring early in a list have had time to be transferred to a secondary memory system, involving categorized and more permanent storage. Belmont and Butterfield (1969) presented evidence which showed that serial position curves for young children and mentally retarded subjects were both flatter than those for normal adults, and showed that both primacy and recency effects were reduced. However, with deaf subjects Conrad (1970) and O'Connor and Hermelin (1973 b) found normal primacy as well as recency effects.

It is said that auditorially presented material in short term memory is stored in temporal order, whereas the one visually presented is stored in spatial form which refers to responses in which the digits were recalled as they appeared from left to right, irrespective of their temporal sequential order. It is reported that the hearing childre recall in a predominantly temporal fashion but the deaf respond almost exclusively in spatial terms. In an interesting study conducted by O'Connor and Hermelin (1972) in which deaf, autistic and sub-normal children were used, showed that the normal hearing children remember incongruently ordered visual displays from the first to the

5.7 last presented item, whereas, deaf, autistic and sub-normal children recall and recognize the digits in their left-to-right order.

Recently, Kool and Tripathi (1977, 1978) reported a shift in the superiority from the auditory mode (AM) to the visual mode (VM) vis-a-vis increase in load of information. Their main study was conducted on 60 undergraduate students divided into 2 groups, group I for the VM and group II for the AM. A typical Peterson and Peterson (1959) technique was followed with 0, 1, 2, 3, 6, 9, 12, and 18 sec retention intervals for 1 row triagram presentation. For 2 or 3 rows trigrams, each subject was asked to report only one row signalled by the E but recall accuracy (RA) of only the last row was scored to keep parity with the results of distractor technique.

Their results based on an ANOVA test showed that for one row CCC RA was perfect with both AM and VM at the 0 sec recall interval, that RA was superior for the AM as compared to the VM at the early recall intervals, and that the trend of data swung in favour of the VM at the 9 sec interval and thereafter. On the other hand, when the items approached 2 rows, the superiority of the VM was held consistently from the 0 to 18 sec intervals as compared to the AM. Furthermore, this advantage to the VM was lost for the first few seconds when the load of material was raised to 3 rows.

5.8 Their Experiment 2 was identical to Experiment 1 except for the material consisting of letters and numbers, e.g. H-4-T. The impact of this constraint caused by coding of two classes of items was recorded with RA at one row presentation under the VM becoming superior to the AM as early as at the 3 sec interval, as compared to 9 sec interval with CCC material. In 2 rows condition, as early as at the 1 sec interval the advantage for the VM was recorded over the AM; whereas, immediate recall at the 0 sec interval yielded superior recall accuracy for the AM. These results indicate that coding in STM becomes more flexible under constraints caused by overloading.

SECTION I

It is assumed that the genesis of internal representation of perceived verbal material is related to, or constrained by, the modes by which it is perceived in the first place. For most hearing people it is assumed that these are by hearing voices or reading print. The deaf are effectively without speech hearing but they can read print. They read speech from lip-movements and are usually taught to do so. They read signs - the language of gesture, and, read finger - spelt words basically letter-by-letter.

5.9 Language plays a fundamental role in thought process. One can say that the thought process is governed by the language. Studies of cognition of the prelingually deaf have traditionally been stimulated by question of the relation between thought and language (Furth, 1964).

The deaf people learn language by learning to read without supporting speech. With extensive practice some of them acquire the rudiments of oral speech. However, most of them remain very poor in their oral speech skills. It has become a challenging task for the researchers to find out the coding mechanism they use in holding the material in their memory.

A few studies have been conducted on deaf people to find out the different strategies used by them in coding informations. It has been reported that profoundly deaf subjects use quite different coding strategies from hearing subjects for immediate recall of consonants (Conrad and Rush, 1965; Conrad, 1970; Locke, 1970). Conrad (1971) reported that hearing subjects use a speech code beginning at about the age of 5 years, while deaf subjects use both dactylic and visual, i.e. shape coding. Earlier work on deaf subjects (Furth, 1964) showed that the deaf have a smaller digit-span than the hearing. According to Conrad (1972), digits are auditorially more discriminable than those of the 10 most discriminable consonants on a digit

5.10 span test with visual presentation. A subject forced to rely on the appearance of the digits would be using a less durable code than a subject naming the digits to himself. The conventional digit span test, then, penalizes the deaf subject, and for the same reason this may also be true when letters are used. The homophony of words is another reason for the poor performance of the deaf people. Such language based reasons show that the deaf would have poor memory spans for verbal material, but these are by and large unconnected with the question of coding.

Locke and Locke (1971) attempted to study recall of deaf and hearing children on the assumption that coding activity could be inferred from the configuration of recall and forgetting patterns. Analysis of results showed that the hearing controls committed the most errors explainable on the basis of phonetic similarity, followed by deaf subjects in intelligible group and the unintelligible group. Visually similar letter confusions were most apparent in the unintelligible deaf group.

The results obtained by Hermelin and O'Connor (1973, 1975) provide evidence for the difference in STM encoding by deaf and hearing children. In the absence of auditory input, the deaf use visual image stores rather than speech codes. Owing to this reason reversed recall by the deaf was better than that of hearing, when both groups were

matched on forward recall. While reviewing their work it was stated that hearing subjects recalled the digits in a first to last and not in a left to right order, while digits were apparently recorded as visual images by the deaf subjects and then "read off" from output from left to right. It is concluded in their research work that since the deaf make use of a short term visual store for recall of the last presented letters of the input display, this strategy was interpreted as elective rather than as due to any rigidly determined mechanism.

In a very interesting study conducted by Blanton and Nunnally (1967) to compare recognition memory of deaf and normal subjects on two types of nonsense syllables, one being high in pronounciability (PR) and the other low in PR, it was found that the deaf performed better than normals on both types of items, but the difference was significant only for the low PR items. They concluded that as pronounciation becomes more difficult, the explicit or implicit motor component and/or auditory cues act as distractors or sources of noise rather than information.

Another factor which invites attention to account for the difference in the coding of deaf and hearing subjects is the role played by rehearsal. Studies on STM of deaf people indicate that their mode of rehearsal seems to be mostly visual-kinesthetic and not acoustic

(Bellugi, et al,1975). Conrad's finding (1965) that poor deaf subjects show more shape confusions than the good deaf subjects (because an increase in error rate tends to be associated with an increase in 'noise'), shows that in memorizing, the deaf minimally use acoustic imagery. To interpret the results on Paivio's (1971) arguments that "visual imagery does not become helpful unless linked to an integrated motor response, such as might be involved in imaginably tracing the outline of a block letter or some other familiar figure ..." (p.180), deaf people's imagery has got to be other than acoustic.

The ease with which words can activate the visual code depends on the imageability of the referents. There are norms available on hearing students (Paivio et al, 1968) which report scaled values on the imagery dimension of words. Using the words from this list which differ in their imagery values, studies have shown that high imagery words which presumably activate both codes are indeed remembered better than low imagery words (Paivio, 1971). This facilitatory effect of imagery on the memory for words has been reported for deaf students by Conlin and Paivio (1975). They selected words which had varying values of imageability and signability dimensions and found a main effect for imagery for both deaf and hearing students and a main effect for signability only for deaf students.

13 The latter result is not surprising considering that hearing students did not know sign language. Moreover, a word high on the signability dimension was probably used more often because of its availability in sign communication and hence was remembered better because of its familiarity value.

Parasnis (1979) conducted an experiment to examine whether imagery mediates the processing and retrieving of signs and to test the relative efficacy of sign and word codes. The results showed that there was an overall difference in the recall performance of hearing and deaf subjects, with hearing subjects doing better than deaf subjects. Apart from the main effect, all interaction effects were not significant. Siple et al,(1977) found that the deaf native speakers of sign language showed better recognition performance when signs were used as presentation or retrieval cues. Deaf subjects had sign language as their dominant language and varied in their English language competence and thus benefitted in general when signs were used as cues. Parasnis (1979) reported that more high imagery items were remembered than low imagery. She also inferred that signs are processed in a way similar to words. In translating from English to sign, it seems that both hearing and deaf subjects employed a strategy different from the strategies used in the other conditions.

EXPERIMENT 5.1

In short, deaf people differ from hearing people with respect to span of memory, nature of interference, backward recall, rehearsal strategy and use of imagery to store and retrieve information in their short and long term stores. Earlier, it has been shown that auditory and visual modes do not yield identical recall accuracy at different recall intervals with variation in load of information (Kool and Tripathi, 1977, 1978). The purpose of the present study is to examine the effect of information load in short term recall of subjects having auditory and visual handicaps. Since deaf subjects predominantly use visual imagery for encoding the material, while, on the other hand, hearing subjects use both auditory and visual modes to retain information in an articulated, integrated store, it is hypothesised that at short recall intervals deaf subjects would perform better than hearing subjects on simple recall of triagrams. However, with increase in the number of triagrams the span of memory will increase and hence hearing subjects would give superior performance than the deaf.

Another hypothesis tested in this study is that if acoustic encoding has any specific advantage in short term recall, the hearing subjects would perform better than the deaf subjects at the early recall intervals but this effect would reverse in favour of the deaf subjects with delay in recall.

.15 Method and Procedure

Sample. Ten deaf and 10 hearing normal subjects participated in this experiment. Both the groups had school or college education and they were matched for their educational achievements and intelligence. Their age ranged between 20 and 23 years with a mean age range of 21.5 years. Deaf subjects were randomly selected from the Training Centre for the Adult Deaf (TCAD) located in the city of Hyderabad in Andhra Pradesh, and hearing normal subjects were randomly selected from H.C. Intermediate College located in the Varanasi city in Uttar Pradesh. All deaf subjects had a profound hearing loss in both ears dating from birth or from very early in life. All deaf subjects were lip read and good in speech though the extent and quality of their articulation varied widely.

Apparatus and Materials. The material used in this experiment consisted of three consonants in one row/two rows printed in black ink on 3" x 3" white card as used by Kool and Tripathi (1977) and a stop watch was used to measure the retention intervals.

Experimental Design and Procedure. A 2 x 2 x 8 within subjects factorial design consisting of group (deaf/hearing), information load (one row/two rows), and retention intervals was used. The recall was obtained at 0, 1, 2, 3, 6, 9, 12 and 18 sec retention intervals. Each subject received a

.16 total of 32 trials in one row condition, and 64 trials in two rows condition. Intertrial interval was 1 minute.

Subjects were brought to the testing room and were seated comfortably. Following instructions were given in writing "Please sit comfortably. There is a slide projector in front of you. At the time of experiment you will be shown slides containing 3 consonants in one row followed by a 3-digit number. You have to repeat the consonant and the number immediately and begin counting backward by 3's from that given number. As soon as you see the 'green' signal, stop counting at once and write the consonants that were shown to you at the beginning of the trial, e.g., suppose you see PKS: followed by 3 digit number, e.g., 240, you immediately repeat 240 and then start counting backward as follows 237, 234, 231, etc until you see a 'green' signal. As soon as a 'green' signal comes PKS is expected to be recalled. You will be given some practice trials. It will help you to understand the procedure."

At the time of two rows presentation the procedure used was similar to the one that was used for one row presentation except that the recall was requested for either the first or the second set of consonants.

Recording of Response. The letters which were recalled correctly were scored as one and those recalled incorrectly were scored zero.

.17 Results and Discussion

Responses of subjects were recorded in terms of recall accuracy. Mean and standard deviations of recall accuracy scores of the deaf and hearing subjects under various retention intervals and information load conditions are presented in Table 5.1.1. The main effects of variables and their interactions were examined in a 3-way analysis of variance (ANOVA) test (2 x 2 x 8). Results are reported in Table 5.1.2. The following main effects were found significant: information load (IL), F (1,18) = 130.38, $p < .01$, with one row recall accuracy (Mean = 1.08) is better than two rows recall accuracy (Mean = 0.64); and retention intervals (RI), F (7,126) = 48.77, $p < .01$, with mean values for 0, 1, 2, 3, 6, 9, 12, and 18 sec retention intervals being 1.26, 1.06, 1.03, 0.92, 0.84, 0.60, 0.55, and 0.54 seconds, respectively. However, the main effect of groups failed to reach the conventional level of significance.

The first order interaction of groups x information load emerged statistically significant, F (1,18) = 5.46, $p < .05$. Mean values for this interaction effect appear in Fig. 5.1.1. It clearly indicates that with increase in information load performance of the groups decreased. Recall accuracy of one row trigrams (CCC) of the deaf subjects is higher than their hearing counterparts and support the findings of Blanton and Nunnally (1967). However, with increase in the

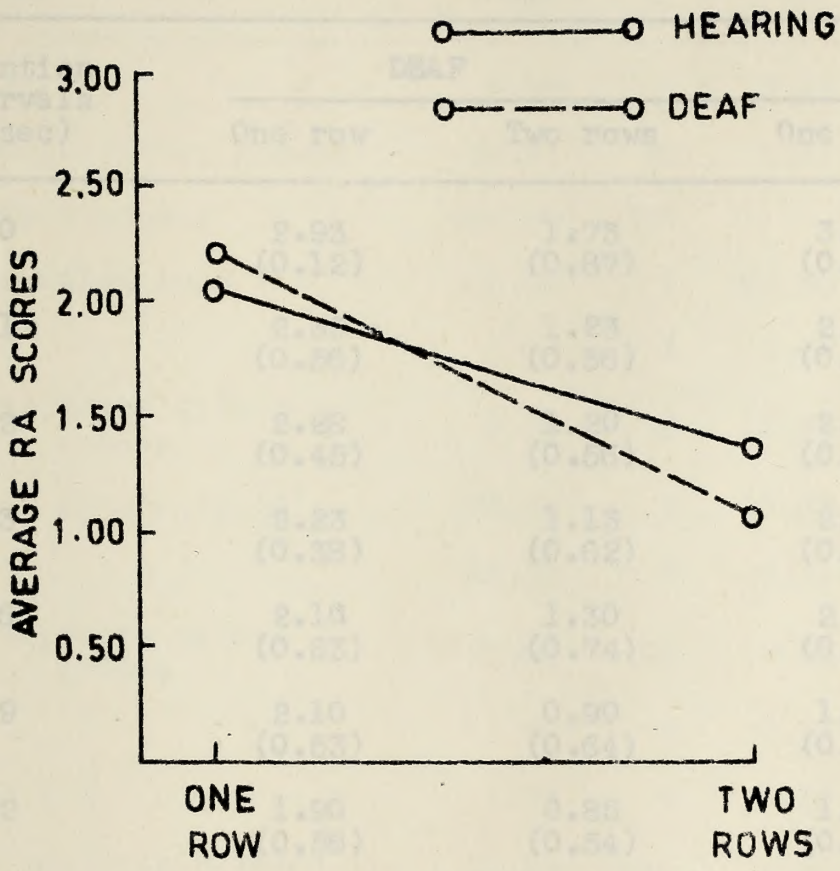
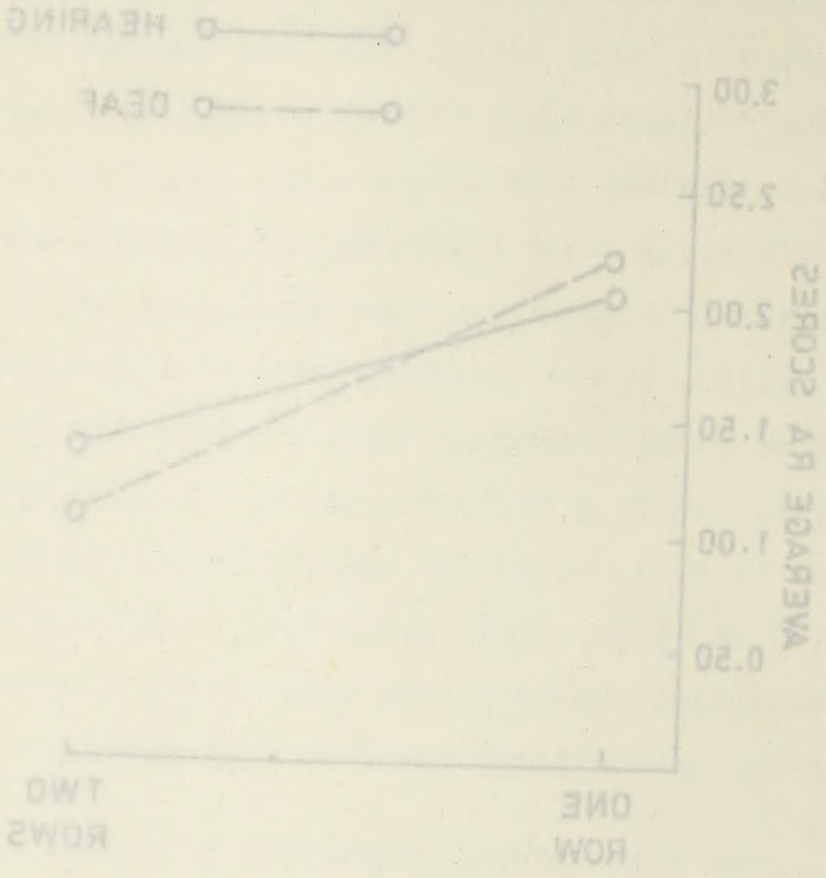


FIG.5.1.1 RECALL ACCURACY SCORES AS A FUNCTION OF ROWS AND GROUPS


HEARING
DEAF
3.00
2.50
2.00
1.50
1.00
0.50
AVERAGE NO. SCORES
ONE
ROW
TWO
ROWS

.18

TABLE 5.1.1

MEAN AND S.D. (IN BRACKETS) VALUES OF DEAF AND HEARING NORMAL SUBJECTS UNDER VARIOUS RETENTION INTERVALS AND INFORMATION LOAD

Retention Intervals (in sec)	DEAF		HEARING	
	One row	Two rows	One row	Two rows
0	2.93 (0.12)	1.73 (0.87)	3.00 (0.00)	2.45 (0.42)
1	2.35 (0.56)	1.23 (0.56)	2.90 (0.13)	2.03 (0.58)
2	2.28 (0.45)	1.20 (0.56)	2.90 (0.21)	1.90 (0.68)
3	2.23 (0.38)	1.13 (0.62)	2.43 (0.41)	1.60 (0.39)
6	2.10 (0.53)	1.30 (0.74)	2.03 (0.61)	1.33 (0.54)
9	2.10 (0.53)	0.90 (0.64)	1.55 (0.59)	0.78 (0.65)
12	1.90 (0.56)	0.85 (0.54)	1.00 (0.87)	0.68 (0.74)
18	2.00 (0.54)	1.03 (0.55)	0.95 (0.75)	0.38 (0.32)

TABLE 5.1.1

MEAN AND S.D. (IN BRACKETS) VALUES OF DEAF AND HEARING NORMAL SUBJECTS UNDER VARIOUS RETENTION INTERVALS AND INFORMATION LOAD

Retention Intervals (in sec)	DEAF		HEARING	
	One row	Two rows	One row	Two rows
0	2.93 (0.12)	1.75 (0.87)	3.00 (0.00)	2.48 (0.42)
1	2.86 (0.86)	1.28 (0.98)	2.90 (0.13)	2.03 (0.88)
2	2.88 (0.46)	1.20 (0.56)	2.90 (0.21)	1.90 (0.88)
3	2.82 (0.38)	1.13 (0.62)	2.43 (0.41)	1.60 (0.89)
6	2.10 (0.53)	1.30 (0.74)	2.03 (0.81)	1.33 (0.86)
9	2.10 (0.53)	0.90 (0.64)	1.56 (0.56)	0.78 (0.65)
12	1.90 (0.96)	0.86 (0.94)	1.00 (0.87)	0.88 (0.74)
18	2.00 (0.94)	1.03 (0.85)	0.86 (0.98)	0.39 (0.32)

5.19

TABLE 5.1.2

SUMMARY OF ANALYSIS OF VARIANCE TEST FOR EXPERIMENT 5.1

Source	SS	df	MS	F	p
Groups (A)	0.13	1	0.13	0.09	-
Subjects within groups	24.61	18	1.37		
Within subjects	226.29	300			
Information load (B)	62.58	1	62.58	130.38	.01
A x B	2.62	1	2.62	5.46	.05
B x subjects within groups	8.58	18	0.48		
Recall intervals (C)	75.14	7	10.73	48.77	.01
A x C	22.78	7	4.11	18.68	.01
C x subjects within groups	27.65	126	0.22		
B x C	1.18	7	0.17	0.85	
A x B x C	1.11	7	0.16	0.80	
BC x subjects within groups	24.65	126	0.20		

number of items to six, which is approximately equal to average memory span, performance of the hearing subjects is better than the deaf subjects. One possible reason of this superiority could be free use of language by hearing subjects, i.e. better articulation and transformation of visually presented verbal material into auditary code, and coding it in short term memory in the form of auditory imagery. On the other hand, the deaf subjects lack free use of language. They use dactylic and visual imagery in coding material in short term memory. Further, the cause of their poor performance could be the nonavailability of more than one modality in encoding of information in short term memory. In an early study Blair (1957) found that the immediate memory span for visually presented digits was very small compared to the hearing control. It was also found that whereas the hearing children had longer forward spans than backward, there was no difference for the deaf. In other words, the deaf subjects do not seem to get support from auditory imagery

Another interaction effect, groups x retention intervals, is also statistically significant, F (7,126) = 18.68, $p < .01$. The mean values of this interaction effect appear in Fig. 5.1.2. It is observed that recall accuracy of the hearing subjects is higher than the deaf subjects at the 0, 1, 2, and 3 sec delay period but this superiority shift in favour of the deaf subjects at longer delay

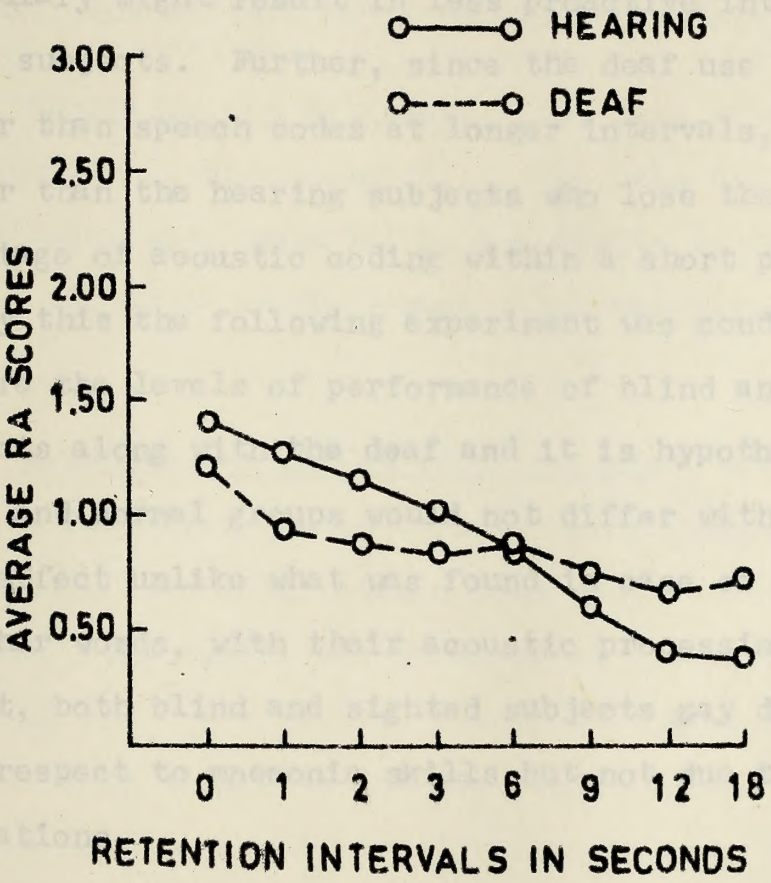


FIG.5.1.2 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND GROUPS

FIG.8.1.2 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND GROUPS

5.21 intervals. It has been observed that the performance of the hearing subjects had deteriorated with increase in the delay period, while it did not show such detrimental effect in the performance of the deaf subjects. This result seems to suggest that the deaf have better visual-perceptual and mnemonic skills, and that the presence of smaller vocabulary might result in less proactive interference for these subjects. Further, since the deaf use visual image rather than speech codes at longer intervals, they perform better than the hearing subjects who lose the initial advantage of acoustic coding within a short period. To verify this the following experiment was conducted to compare the levels of performance of blind and sighted subjects along with the deaf and it is hypothesized and that blind and normal groups would not differ with respect to the load effect unlike what was found in case of the deaf group. In other words, with their acoustic processing capacity intact, both blind and sighted subjects may differ only with respect to mnemonic skills but not due to any capacity limitations.

EXPERIMENT 5.2

Method and Procedure

Sample. Twenty subjects, 10 blind and 10 sighted, volunteered in this experiment. The age of subjects ranged from 21 to 24 with a mean age of 22.5 years. The blind

5.22 subjects were randomly selected from the hostels for the blind located in the city of Hyderabad in Andhra Pradesh. These subjects were either congenitally blind or had lost their vision very early in life. The sighted subjects were randomly selected from a degree college located in the city of Varanasi in Uttar Pradesh. Both the groups were matched for their educational achievements and intelligence.

Apparatus and Materials. The same material was used as described in Experiment 5.1. The only difference was that the trigrams were recorded in a cassette instead of printing them on the white cards. A stop watch was also used to record time.

Experimental Design and Procedure. A 2 x 2 x 8 within subjects factorial design consisting of groups (Blind/sighted) information load (one row/two rows) and retention intervals was used. The recall was obtained at the 0, 1, 2, 3, 6, 9, 12 and 18 sec retention intervals. Each subject received a total of 32 trials in one row condition and 64 trials in two rows condition. Intertrial interval was 1 minute.

Procedure was kept exactly similar to the one followed for the previous experiment, except presentation of material which was auditory instead of visual.

Recording of Response. The letters which were recalled correctly were scored as one and those recalled incorrectly were scored zero.

5.23 Results and Discussion

Mean and standard deviations of recall accuracy scores of the blind and sighted subjects under various retention intervals and information load conditions are presented in Table 5.2.1. A 3-way analysis of various (ANOVA) test (2 x 2 x 8) as employed for the data in the previous experiment was used to compute the data. Results are reported in Table 5.2.2. All the main effects were significant. Blind subjects (mean = 1.18) showed less errors in recall of trigrams than their sighted counterparts (mean = 0.74), F (1,18) = 117.12, $p < .01$. Main effect of information load emerged statistically significant, F (1,18) = 165.94, $p < .01$, showing recall accuracy of one row trigrams (mean = 1.11) better than the two rows trigrams (mean = 0.81). Main effect of retention intervals (RI) is also found statistically significant, F (7,126) = 77.05, $p < .01$. Mean values for 0, 1, 2, 3, 6, 9, 12, and 18 second retention intervals are 1.39, 1.23, 1.18, 1.09, 0.84, 0.72, 0.71, and 0.53, respectively, and showed a significant loss of material with delay, F (7,126) = 77.05, $p < .01$.

First order interaction effects of groups x information load, and information load x retention intervals were insignificant. However, groups x retention intervals effect was significant, F (7,126) = 10.26, $p < .01$. The mean values of this interaction effect appear in Fig. 5.2.1. The

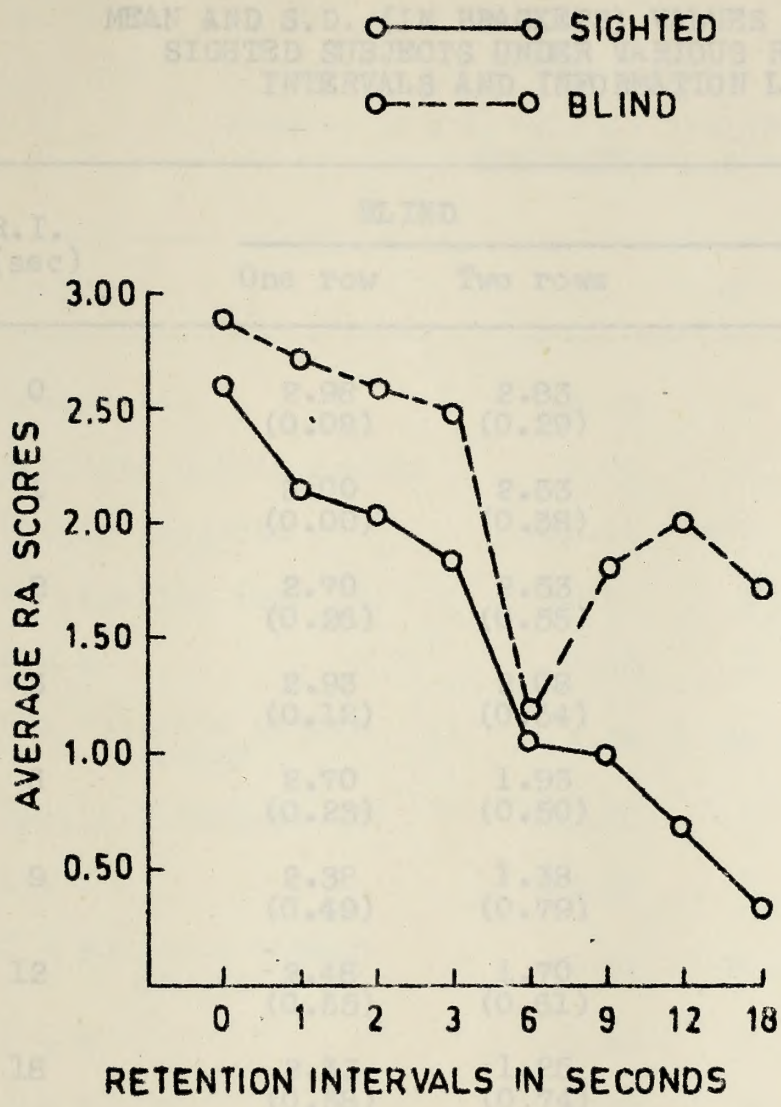


FIG.5.2.1 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND GROUPS

FIG.5.2.1 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND GROUPS

5.24

TABLE 5.2.1

MEAN AND S.D. (IN BRACKETS) VALUES OF BLIND AND SIGHTED SUBJECTS UNDER VARIOUS RETENTION INTERVALS AND INFORMATION LOAD

R.I. (sec)	BLIND		SIGHTED	
	One row	Two rows	One row	Two rows
0	2.98 (0.08)	2.83 (0.29)	2.90 (0.24)	2.43 (0.33)
1	3.00 (0.00)	2.53 (0.38)	2.60 (0.29)	1.73 (0.67)
2	2.70 (0.26)	2.53 (0.55)	2.48 (0.30)	1.73 (0.51)
3	2.93 (0.12)	2.08 (0.54)	2.30 (0.35)	1.40 (0.66)
6	2.70 (0.23)	1.93 (0.50)	1.25 (0.68)	0.85 (0.57)
9	2.38 (0.49)	1.38 (0.79)	1.10 (0.46)	0.95 (0.47)
12	2.48 (0.55)	1.70 (0.61)	1.03 (0.48)	0.45 (0.54)
18	2.33 (0.58)	1.25 (0.74)	0.53 (0.62)	0.15 (0.24)

TABLE 5.2.1

MEAN AND S.D. (IN BRACKETS) VALUES OF BLIND AND SIGHTED SUBJECTS UNDER VARIOUS RESTRICTION INTERVALS AND INFORMATION LOAD

R.I. (sec)	BLIND		SIGHTED	
	One row	Two rows	One row	Two rows
0	2.98 (0.05)	2.83 (0.25)	2.40 (0.24)	2.45 (0.35)
1	3.00 (0.00)	2.84 (0.38)	2.60 (0.28)	1.93 (0.07)
2	2.70 (0.26)	2.53 (0.55)	2.48 (0.20)	1.73 (0.21)
3	2.93 (0.12)	2.08 (0.84)	2.30 (0.35)	1.40 (0.66)
6	2.70 (0.25)	1.93 (0.80)	1.26 (0.69)	0.85 (0.87)
9	2.32 (0.49)	1.38 (0.79)	1.10 (0.46)	0.58 (0.37)
12	2.48 (0.55)	1.70 (0.61)	1.05 (0.46)	0.45 (0.54)
18	2.33 (0.58)	1.26 (0.74)	0.53 (0.62)	0.15 (0.24)

5.25

TABLE 5.2.2

SUMMARY OF ANALYSIS OF VARIANCE TEST FOR EXPERIMENT 5.2

Source	SS	df	MS	F	p
Groups (A)	59.73	1	59.73	117.12	.01
Subjects within groups	9.09	18	0.51		
Within subjects	212.09	300			
Information load (B)	29.87	1	29.87	165.94	.01
A x B	0.18	1	0.18	1.00	
B x subjects within groups	3.24	18	0.18		
Recall Intervals (C)	102.50	7	14.64	77.05	.01
A x C	13.68	7	1.95	10.26	.01
C x subjects within groups	24.44	126	0.19		
B x C	2.40	7	0.34	1.36	
A x B x C	4.53	7	0.65	2.60	.05
BC x subjects within groups	31.25	126	0.25		

5.26 difference between recall accuracy of the blind and sighted subjects increased at longer retention intervals but this was not so at shorter retention intervals.

The second order interaction effect of groups x information load x retention intervals also emerged statistically significant, F (7,126) = 2.60, $p < .05$. The mean values for this interaction effect appear in Fig. 5.2.2. It is observed that recall accuracy of the blind subjects for both one row and two row trigrams is better than their sighted counterparts, particularly at delayed retention intervals. These results suggest that the blind subject have better acoustic-perceptual and mnemonic skills than the sighted counterparts and that they perform better owing to their less susceptibility to distractors.

As early as in the late nineteenth century William James (1890) articulated a common conception that blindness tends to promote the learning of unusual perceptual skills in non-visual modalities (Gibson, 1969, p.10). More recently, the empirical work of Witkin et al (1968) seems to support this view. His blind subjects obtained much higher score than the sighted subjects in both the auditory embedded figures test and digit span sub-test of the Wechsler test. Liddle (1969) also pointed out that the most important sensory modalities in the activities of the blind are proprioception and hearing. For this reason a

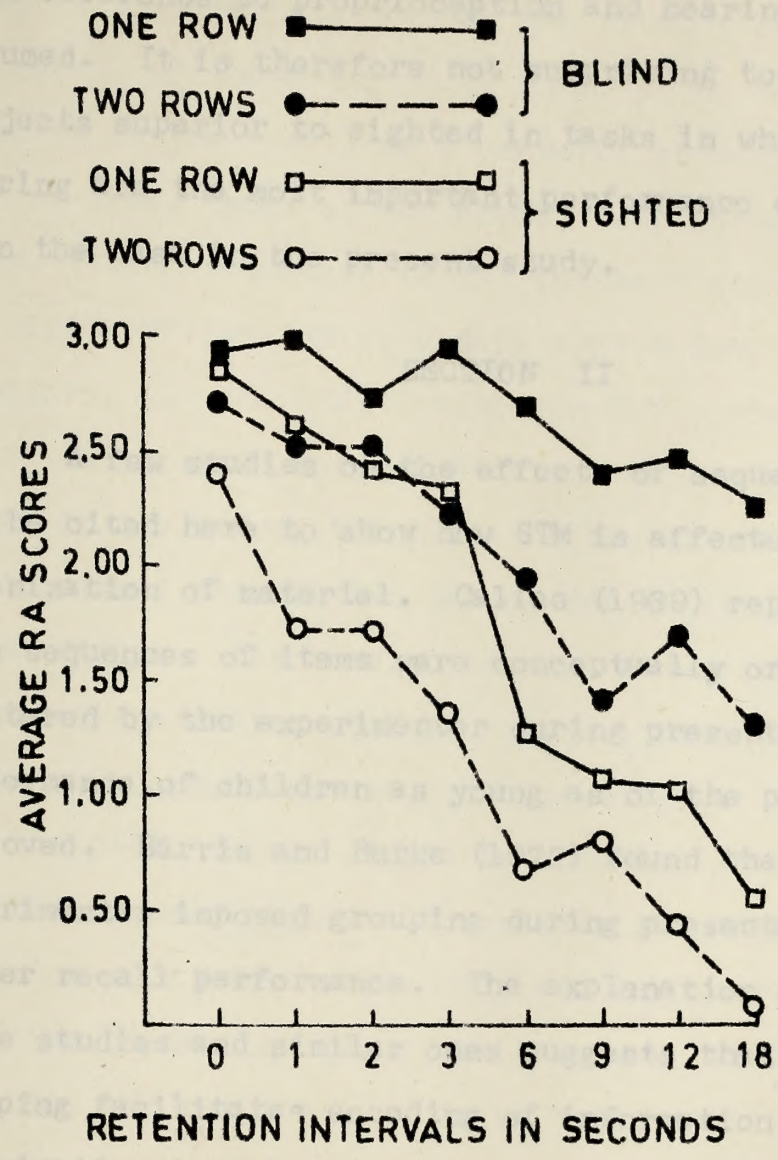
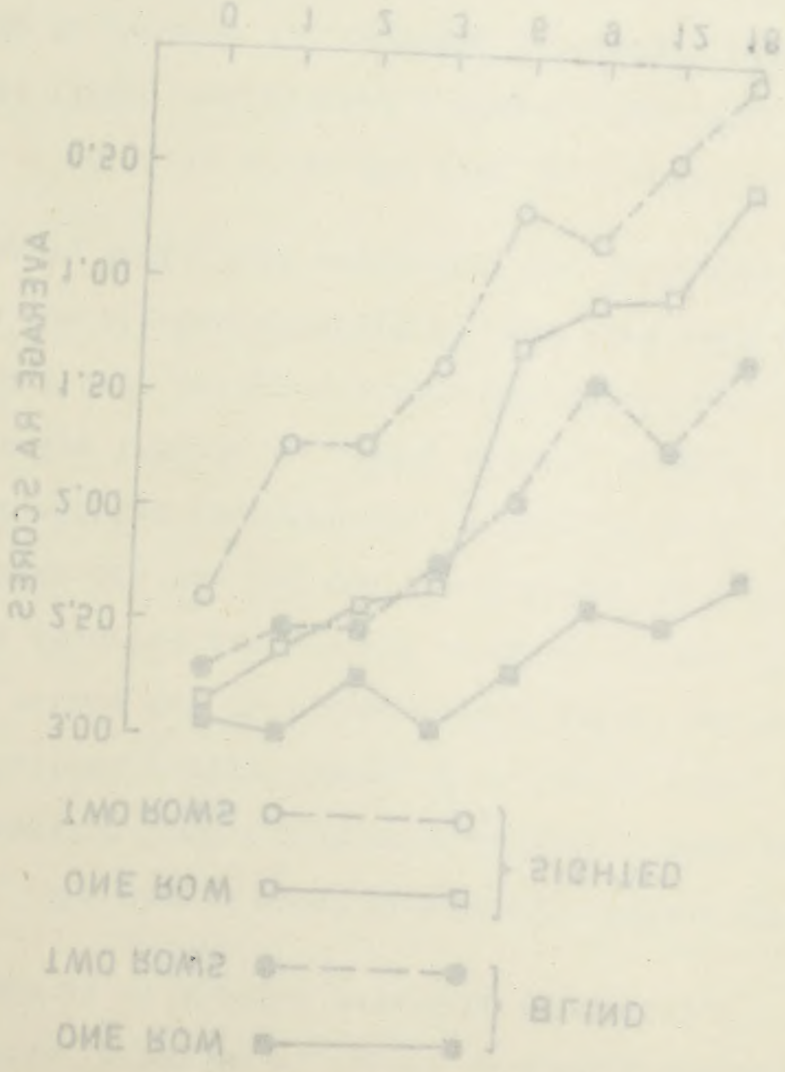


FIG. 5.2.2 RECALL ACCURACY SCORES AS A FUNCTION OF INFORMATION LOAD AND RETENTION INTERVALS


TWO ROWS
ONE ROW
SIGHTED
TWO ROWS
ONE ROW
BLIND

5.27 possibility that the blind possesses a particular sensitivity with reference to proprioception and hearing is often assumed. It is therefore not surprising to find blind subjects superior to sighted in tasks in which touch and hearing are the most important performance elements, as has been the case in the present study.

SECTION II

A few studies on the effects of sequencing of items may be cited here to show how STM is affected by the organization of material. Calfee (1969) reported that when sequences of items were conceptually organized or clustered by the experimenter during presentation, the STM performance of children as young as of the preschool age improved. Harris and Burke (1972) found that the experimenter imposed grouping during presentation yielded higher recall performance. The explanation offered for these studies and similar ones suggests that the imposed grouping facilitates encoding of information and the organization is related to the structure of a sequence, i.e., grouping of digits, rather than to the content of its items.

In a recent experiment Kool (1975) pursued a simple and straight procedure to bring out the role of automatic processes. He proposed that if three digits

5.27

5.28 are presented in a sequence such that the last one in the order of presentation becomes the product of the first two, the recall of these digits is bound to be superior as compared to the recall of a sequence of unrelated digits. He used three types of sequences, each containing three items. These sequences varied in their structure as follows: (1) digits of the Additive Set, e.g. 5-3-8, were additive in nature; (2) the Additive-Random Set contained the same digits as reported for the Additive set, except for a change in the order, which also affected the structure of the sequence; and (3) the Random Set which consisted of random digits. His results showed that recall accuracy was highest for additive sequence digits, followed by additive random and random sequences, respectively. It was concluded that the facilitative effect in encoding of such a sequenced material becomes highly automatic as it refers to the formation of a habit while subjects acquired skill in mastering tasks involving addition ever since their schooling had started. In fact, this habit is the product of first mathematical operation which every one acquires in adding and counting and it is being taught in a forward-going way.

Since all the subjects in Kool's experiment were senior graduate students of a university, the interest in his next experiment (Kool and Agarwal, 1980) focussed on

5.29 the developmental aspect of such encoding. It is well known that with cognitive growth the child is able to handle more material and more complex information at a faster rate. For example, a young child counts on fingers to tell 3 + 3 = 6 but as he grows older his processing time reduces. Any type of organisation which fails to show such a correspondence would be ineffective in facilitating recall accuracy. Thus, a 7 year old child who has just started learning 5 + 3 = 8 is likely to show superior recall for a set having digits 5-3-8 as compared to 5-8-3 or 7-4-9. However, an older child, say of 11-12 years, who can handle more material and more complex information than the younger ones, is not likely to show any distinct advantage in the recall of organized material. For him, both types of material are easy to recall. Thus with increase in the complexity of material of similar type but having larger digits, e.g. 23-9-32, Kool and Agarwal (1980) obtained the advantage in recall of material having additive sequence over nonadditive. Raising the difficulty level to all two-digit numerals, e.g. 32-26-58, wiped out facilitative effect because encoding fails to be guided by a highly compulsive, repetitive habitual set, labelled automatic by Posner and Warren (1972).

Studies have been conducted to compare the processing of visually presented words and digits, between the deaf and hearing subjects. Furth (1966) argued that the damage

5.30 to cognition, resulting from congenital deafness, has consequences only for verbal and associated abilities. He suggested that an alternative link between the structuring and interpretation of stimuli exists through imagery. STM process of the deaf people, as already pointed out, indicates that their mode of rehearsal is mostly visual-kinesthetic (Bellugi, et al, 1975). Reference was also made to the studies conducted by Hermelin and O'Connor (1973, 1975) in which they showed how deaf children processed digits in the left to right order, regardless of the temporal sequence.

An attempt is made in the present study to examine the encoding of visually presented additive and non-additive digital material and its processing by the deaf and hearing subjects. It has been hypothesized that deaf and hearing subjects would differ in their encoding of sequential and non-sequential material, i.e., additive, lower additive, and additive random sets of digits as used by Kool (1975). It has also been hypothesized that the performance of subjects in all the three conditions would deteriorate with delay in recall but the deaf and hearing subjects would not show identical trends owing to their difference in encoding the material.

5.31

EXPERIMENT 5.3

Method and Procedure

Sample. Ninety adults, 45 deaf and 45 hearing, acted as subjects. Deaf subjects were randomly selected from the Training Centre for the Adult Deaf (TCAD), Hyderabad. Hearing subjects were also randomly selected from the Central Training Institute (CTI) of the same city. Subjects had a profound hearing loss in both ears dating from birth or from the first 12 months of life. All deaf subjects were able to lip read and vocalize, though the quality and the extent of articulation varied widely. The deaf and hearing groups were matched for their intelligence, age and educational achievement.

Apparatus and Materials. Three types of digital material was presented in a sequence. These sequences varied in their structure as follows: (a) digits of the additive set (A), e.g., 58-6-64, were additive in nature; (b) Another additive set containing the same digits (LA) as in group (a) for a change in order which affected the structure of the sequence, e.g., 6-58-64, and (c) the additive random set (AR), e.g., 64-6-58. Filler numeral sets were also used which consisted of either only alphabets or a combination of alphabets and digits, e.g., HCK, and ROC, etc.

5.32 Experimental Design and Procedure. A 2 x 3 x 4 within subjects factorial design consisting of groups (Deaf/Hearing), sets (Additive, Lower Additive and Additive Random), and recall intervals (0, 3, 9 and 18 second) was used. Six independent groups were formed, i.e., Hearing-Additive, Hearing-Lower Additive, Hearing-Additive Random, Deaf-Additive, Deaf-Lower Additive, and Deaf-Additive Random. Fifteen different subjects were randomly assigned to each of these groups. Each subject received twelve trials by combining three conditions over four retention intervals.

Each subject was brought individually in the testing room and seated comfortably. In front of the subject there was a table on which a slide projector was kept: All subjects received following written instructions "Please sit against the back of your chair so that you feel comfortable. In front of you is a slide projector. The light is now on. This means that we are ready to begin a trial. I am giving you a paper to write whatever is shown to you. Some numbers or alphabets or both mixed will be shown in a slide followed by a number. You are to read it aloud immediately after presentation and begin counting backward by 3s from the given number. I might show you, 28-4-32, 398. After reading it you say 395, 392, 389 etc, until you see a red signal. When you see the red signal, stop counting and immediately write letters or digits that were shown in the

5.33 beginning of the trial. There will be a short rest period and then the light will come on again and we will begin with the next trial." The items were briefly exposed for 2.5 seconds. Each subject received three familiarization trials followed by twelve test trials.

Recording of Response. The digits which were recalled correctly in their original order were scored as one and those recalled incorrectly or irrespective of their original order were scored zero.

Results and Discussion

Mean and standard deviations of recall accuracy scores of the deaf and hearing subjects under various retention intervals and sets are presented in Table 5.3.1. (Fig. 5.3.1 RA as a function of various sets (A, LA and AR), retention intervals and groups). A 3 way analysis of variance test was computed to analyse the recall accuracy scores. Results are reported in Table 5.3.2. Except the main effects of groups all other main effects were significant: Retention Intervals F (3,253) = 55.91, $p < .01$), and sets (F (2,84) = 8.70, $p < .01$) . A comparison of the mean recall accuracy scores of A, LA, AR conditions shows that the recall of A is greater than AR and AR is better than the LA condition.

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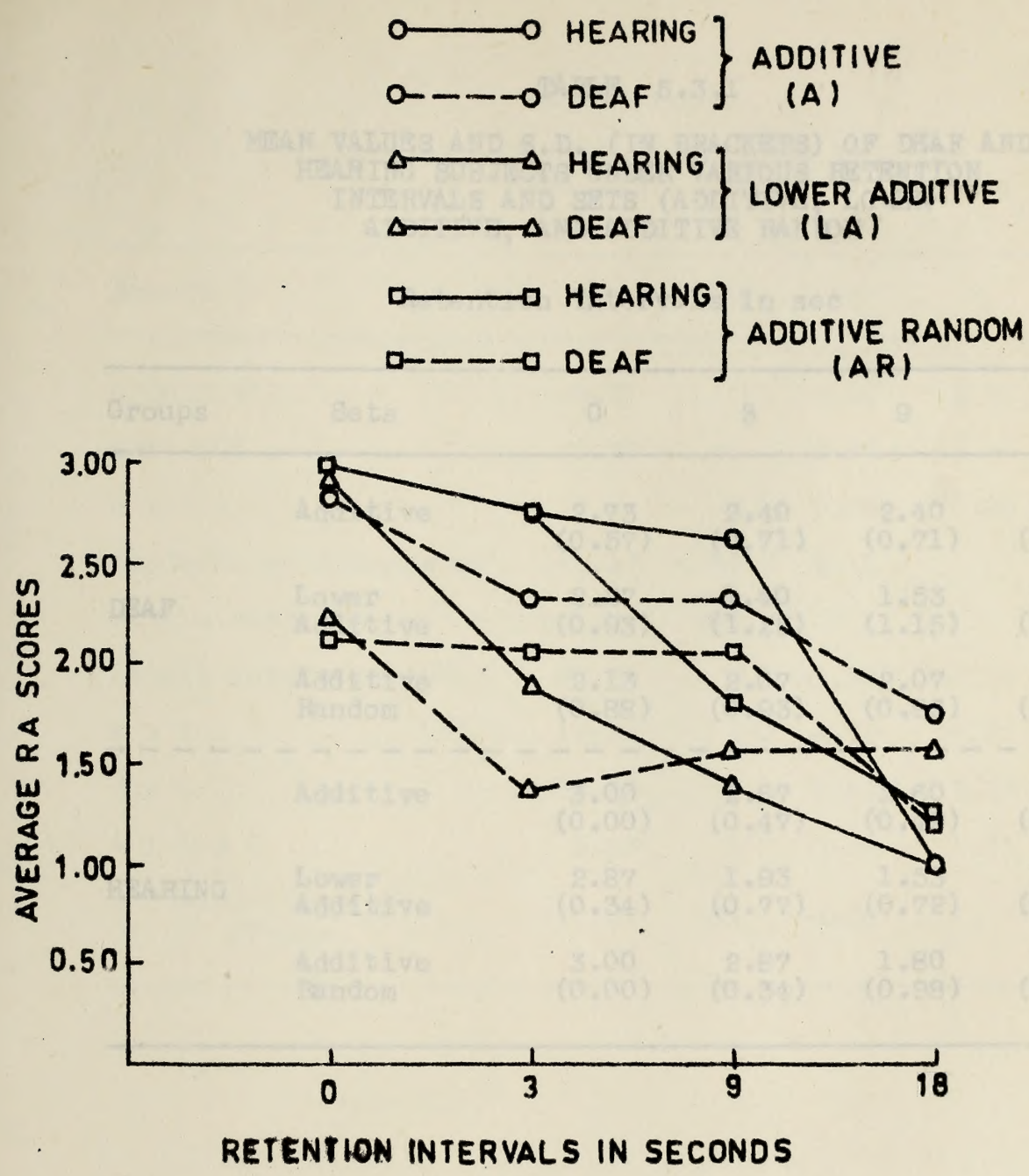


FIG.5.3.1 RECALL ACCURACY SCORES AS A FUNCTION OF RI, SETS, AND GROUPS

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5.34

TABLE 5.3.1

MEAN VALUES AND S.D. (IN BRACKETS) OF DEAF AND HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS AND SETS (ADDITIVE, LOWER ADDITIVE, AND ADDITIVE RANDOM

Retention Intervals in sec

Groups	Sets	0	3	9	18
DEAF	Additive	2.73 (0.57)	2.40 (0.71)	2.40 (0.71)	1.67 (1.07)
	Lower Additive	2.27 (0.93)	1.40 (1.25)	1.53 (1.15)	1.40 (1.25)
	Additive Random	2.13 (0.88)	2.07 (0.93)	2.07 (0.93)	1.20 (1.11)
HEARING	Additive	3.00 (0.00)	2.67 (0.47)	2.60 (0.49)	1.00 (0.73)
	Lower Additive	2.87 (0.34)	1.93 (0.77)	1.53 (0.72)	1.00 (0.73)
	Additive Random	3.00 (0.00)	2.87 (0.34)	1.80 (0.98)	1.27 (0.77)

5.35

TABLE 5.3.2

SUMMARY OF ANALYSIS OF VARIANCE TEST FOR EXPERIMENT 5.3

Source	SS	df	MS	F	p
Groups (A)	3.21	1	3.21	2.89	
Sets (C)	19.32	2	9.66	8.70	.01
A x C	1.85	2	0.93	0.84	
Subjects within groups	93.47	84	1.11		
Within subjects	261.75	270			
Recall Intervals (RI)	93.93	3	31.31	55.91	.01
A x B	13.22	3	4.41	7.88	.01
B x C	10.85	6	1.81	3.23	.01
A x B x C	3.53	6	0.59	1.05	
B x subjects within groups	140.22	252	0.56		

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Within subjects	261.75	270			
Recall Intervals (RI)	93.93	3	31.31	68.91	.01
A x B	13.22	3	4.41	9.69	.01
B x C	10.85	6	1.81	3.98	.01
A x B x C	3.53	6	0.59	1.05	
B x subjects within groups	140.29	252	0.56		

5.36 The first order interaction groups x sets is not found significant. However, groups x retention intervals effect is significant, (F (3,252) = 7.88, $p < .01$) . The mean values for this interaction effect appear in Fig. 5.3.2. It is observed that the recall accuracy of the hearing subjects in the beginning, i.e. at 0 and 3 sec retention intervals, is higher than those in deaf group. However, with the increase in the recall intervals performance of the deaf subjects becomes superior to that of hearing counterparts. Another interaction effect of retention intervals x sets is also significant, F (6,252) = 3.23, $p < .01$. The mean values for this interaction effect appear in Fig. 5.3.3. It is observed that recall accuracy of the additive condition is higher than both LA and AR and these results support Kool's earlier findings (1975).

Generally speaking, STM consists of an echo from which items in a verbal series could be effortlessly parroted back (Waugh, 1961). In case of deaf subjects in whom acoustic experience is absent, the mode of encoding is not auditory, but visual-kinesthetic. Since STM is characterized by acoustic properties coupled with limited capacity and rapid loss, the initial echoic advantage with which items are retrieved is not available to the deaf subjects. This is consistently true for all the sets, i.e. A, LA and AR, and is indicative of the significant role

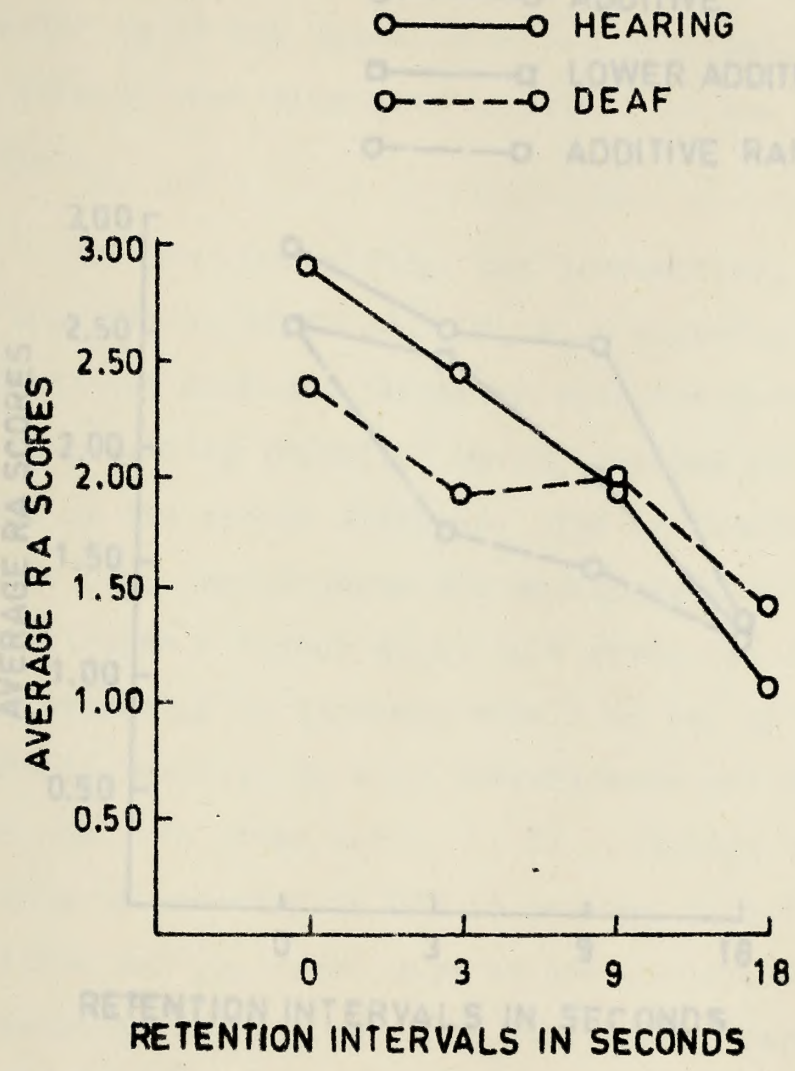


FIG.5.3.2 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND GROUPS

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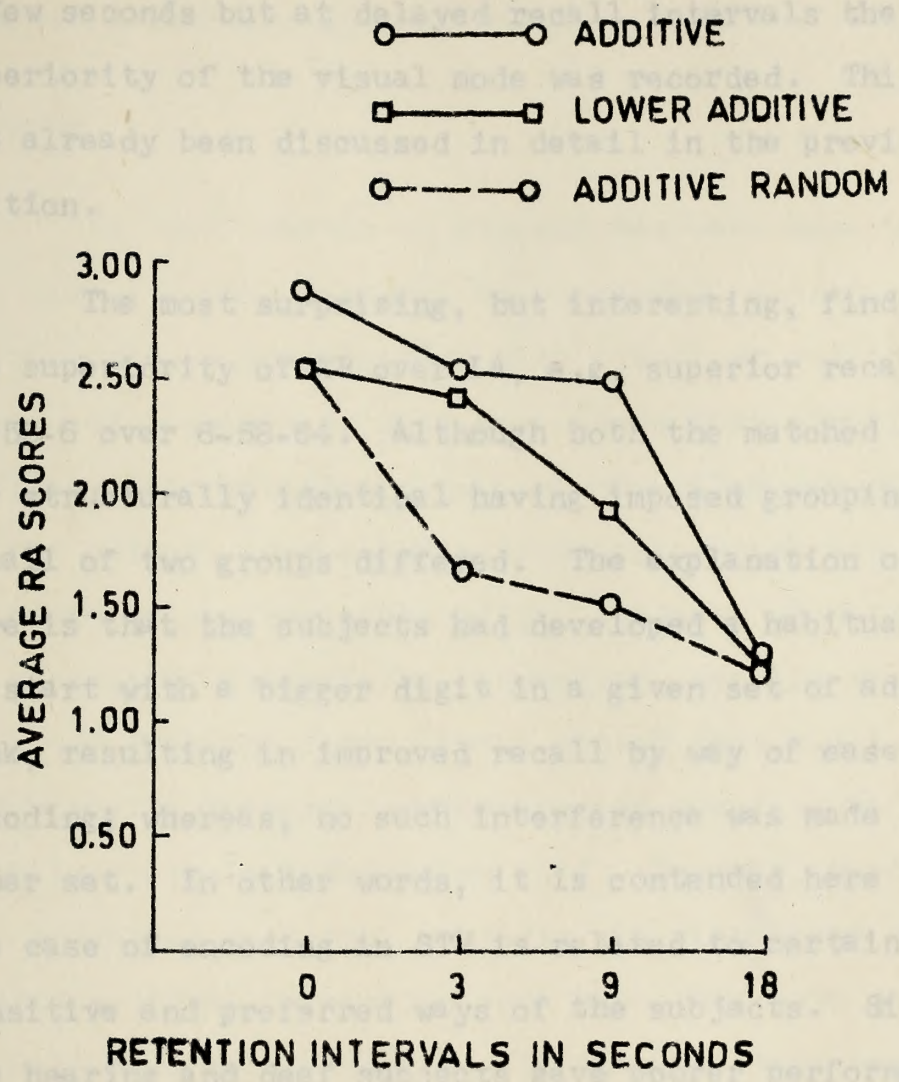


FIG.5.3.3 RECALL ACCURACY SCORES AS A FUNCTION OF RI AND SETS

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5.37 acoustic properties play in short term recall of material. Earlier, using CCCs, Kool and Tripathi (1977) also reported that the auditory mode is superior to the visual mode for a few seconds but at delayed recall intervals the superiority of the visual mode was recorded. This point has already been discussed in detail in the previous section.

The most surprising, but interesting, finding concerns the superiority of AR over LA, e.g. superior recall of 64-58-6 over 6-58-64. Although both the matched sets are structurally identical having imposed grouping, the recall of two groups differed. The explanation offered here is that the subjects had developed a habitual system to start with a bigger digit in a given set of addition task, resulting in improved recall by way of ease of encoding; whereas, no such interference was made in the other set. In other words, it is contended here that the case of encoding in STM is related to certain highly sensitive and preferred ways of the subjects. Since both the hearing and deaf subjects gave poorer performance in the LA than AR, particularly at shorter retention intervals, it is contended here that the deaf subjects in this experiment, who had good vocalization and lip movement, tended to code the material in much the same as those in the hearing group. Hermelin and O'Connor (1973) reported that some deaf children, like the hearing, seem to encode

5.38 and store visually presented digits in a temporal successive order. In other words, the strategies adopted by the deaf resemble those in the normal hearing group, specially when speech impairment is less.

SUMMARY

In this chapter an attempt has been made to show how simple verbal material is processed, stored, and retrieved upon presentation with visual or auditory mode. Review of research in this area shows that visual and auditory informations are not retrieved identically as seen in the output. For example, phonetic errors are often recorded in the responses of the subjects when the material is presented auditorially. Moreover, earlier studies by Kool and Tripathi (1977, 1978) showed that auditorially and visually presented materials are recalled differently with increase in information load. However, their study was conducted on normal subjects who might have used auditory-visual integrated code such that pure modality effects were not available. To examine their results rigorously, normal subjects were treated as a control group and their performance was matched with the blind subjects who were given auditory material and also with the deaf subjects who were given similar visual material. Experiment 5.1 on deaf vs. normals showed that the normal subjects held the information better than their deaf

5.39 counterparts at short intervals only but at long delays the trend of results changed completely. This clearly shows that in the beginning of the input the information is supported by auditory codes. In Experiment 5.2 involving comparison between normal and blind subjects it was found that the blind subjects perform better than the sighted at all retention intervals of auditorially presented materials. This difference was attributed to less distraction, better mnemonic skills, or acoustic perceptual capacities of the blind people.

In Section II, an attempt was made to study how automatic encoding takes place in the hearing and deaf subjects for different sequences of a numeral set which can be made additive in nature. The results again showed that visual information was better held in the normal subjects at short retention intervals and thereby confirmed the findings of the previous studies.

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CHAPTER 6

OVERVIEW, SUGGESTIONS AND RECOMMENDATIONS

OVERVIEW

Among the three memory stores - sensory, short term and long term - the intermediate one (short term) is basically important as it acts as a buffer for holding or rejecting the material. The properties of this unique 'working memory' are several, e.g. limited capacity, rapid decay, and lack of rehearsal, and it is particularly interesting to find out how storage and retrieval processes are shaped in this store in the absence of a vital input like vision. With this in mind, a number of variables relating to movement, touch and audition were studied in recall of tasks by the blind and sighted subjects and based on our findings, a few suggestions and recommendations are made.

Location and Distance

Although codability of location and distance information is still being very much debated (for a useful review see Singh, 1980), at least one final conclusion which

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Location and Distance

Although modability of location and distance information is still being very much debated (for a useful review see Singh, 1980), at least one final conclusion which

.2 emerges from our results is that in both blind and sighted groups location is better recalled than distance. The reason is that receptors for location information are available (Skoglund, 1956) and have access to central coding but this is not so for distance because it is 'not the language of muscles' (Keele, in press).

It is on the distance task that the differences between the blind and sighted groups emerge very sharply. In Experiments 3.1 and 3.3 it was very clearly found that blind subjects gave very poor recall of targets, particularly short ones on immediate recall or soon after, than their sighted counterparts, although with lapse of time they were relatively not so inferior in their performance. A comparative study of performance of these two groups on linear and curvilinear tasks showed that blind subjects' performance was somewhat inconsistent on these two types of tasks in comparison to the sighted, e.g. on long targets the blind subjects performed better than the sighted in the linear task but not on the curvilinear. This result suggests that utilization of feedback dependent movements like long ones is beneficial to blind people only when spatial layout is adequately represented in them as in case of a linear task; without this their performance is no better than their sighted counterparts as was found in the curvilinear tasks.

.3 Results of Experiment 3.4 clearly show that in all the 3 error analyses (AE, VE and CE) location did not cause differential effect in the recall accuracy of the blind and sighted subjects but it was very vividly observed in the distance task. Again, in Experiment 3.5 illustrating the effect of prior activities on recall accuracy, it was distance which was adversely affected in the blind group, whereas the sighted group showed hardly any deterioration in performance upon increase in PI. An interesting point in this experiment is the fact that this effect of prior activities on the blind subjects is limited because their recall errors did not increase when 2 prior activities were raised to 4. It shows that the blind people also use spatial judgements, though not identical to that of the sighted, of some type presumably based on their kinesthetic, tactual or haptic cues (Millar, 1977). Support to this explanation is also available in studies conducted in the University of Leningrad, Russia, on blind children in which it was reported that the correlation between the position of the blind child's body and limbs enables him to determine the correlation between imagined points and objects (Yarmolenko, 1959). Recent work on this issue based on applications of programming aspect of movements (for review see Keele, in press) shows that the organism need no prior knowledge of the starting location of a body member: Regardless of

6.4 initial conditions, the body member would move till the tensions balance" and hence coding of distance can be better understood in terms of 'derivative of the forces put into acceleration and deceleration and their timing' (ibid). This point will be further elaborated in the discussion on preselection.

In short, it is easy to show how location information is coded kinesthetically with sufficient experience and training in using kinesthetic modality, but a lot of mystery surrounds the reproduction of distance information which one has to make so frequently and often without an augmented feedback or a supporting reference system.

As for the present it is known very well from the available theories that the latter one is guided by some nonmotor store like vision (Roy, 1978); or that it is dependent upon the relative amount of distance and location information present in the criterion movement as suggested by Stelmach and McCraken (1978). The latter view supports that extrapolation from the start and finish locations of the criterion movement helps memory of distance and that there is hardly any value in retaining the concept of dual storage of location and distance.

6.5 Preselection

It is generally believed that reproduction of a response is superior if it is self-selected but this is unfortunately not the case with the blind groups we studied. Our data run very much in counter to this contention and a bit surprisingly, too, for in our pilot testing we had begun with an assumption that refinement of kinesthetic and tactual experiences would sharpen the level of performance of the blind people and hence better reproduction of preselected tasks.

The fact that such a simple voluntary response is not objectively known and so poorly investigated is a very glaring example of our gross misunderstanding of the human system. If we scan the educational programmes and practices of the blind people we generally find that a great deal of emphasis is laid on their own efforts to shape responses with prior knowledge/information about the tasks which, in essence, involve more or less voluntary and self selected responses as in case of preselection. This issue raises a very fundamental question: To what extent are self-chosen responses helpful to blind people? A very clear answer from our analysis is that it is not, unless the instructor of blind people has some ulterior motives like injecting confidence to initiate mobility in them. And yet the popular belief about the potential effects of

6.3 Preselection

6.6 self-selected responses are broadly generalized by both laymen as well as educationists and psychologists. Of course, this is viewed with an assumption that what is useful in an approach based on commonsense or existing practices does not always have the support of scientific analysis. For example, psychologists have time and again shown that recall of material in active voice is better than passive, but even then most of the reporting in newspapers, magazines or textbooks is made in passive voice only.

Our results on blind people are unique and have several theoretical and practical implications. First, it is not clear why blind people fail to make use of preselection, a finding which was repeatedly and consistently found in our several experiments. To say that they have poor knowledge of movement of space is wrong because in the location tasks they performed as good as their sighted counterparts.

Second, if an analysis of movement reproduction is to be made based on image, as Kelso had done by stressing that 'in preselecting a movement, an internal representation of the anticipated sensory consequences of that movement is available' (ibid, p. 110), the role of image as an internal model for motor representation must be brought out. For example, the distinction between how something

6.7 looked (appearance) and what it looked like is very important as this explanation, according to Bower (1972), is the same as the difference between a sighted and blind person's knowledge of the visual world. The difficulty in describing the difference is that whereas we can express what something looks like but not how it appears. In other words, both blind and sighted people reproduce targets based on their available modes of coding sensory information but the fundamental difference between them concerning representation of spatial layout with or without vision remains and, therefore, movements generated information with or without vision have different schema. Quoting William James (1890), Bower wrote, 'The best taught blind pupil ... yet lacks a knowledge which the least instructed seeing baby has. They can never show him what light is in its 'first intention', and the loss of that sensible knowledge no book learning can replace' (p. 53). In other words, the failure to use preselected information by the blind is due to their inability to relate 'how the movement was' with 'what it looked like'.

Not surprising, then, is the finding of Kelso that visually guided movements in preselection were very poorly recalled when the subjects rely on visual reference system in coding their movements. According to Posner, et al (1976), vision dominates over other sense modalities even when the subject is in a neutral set. Obviously then, the

6.8 most deleterious effects resulted in visual conditions alone because information about modality of output in Kelso's experiment was visual in nature.

Although Roy (1978) had indicated that preselection may facilitate the coding of extent in a perceptual reference system other than kinesthesis, say vision, the present comparative results on the blind and sighted groups directly show how preselection is effectively used by the sighted group but not the blind group. If preselection enables more accurate utilization of efference (Jones, 1972, 1974), or that the efference is used in a feedforward process to sensatize the sensory centres in the central nervous system (Stelmach et al, 1975), the blind subjects who primarily depend upon their kinesthetic cues to reproduce their responses would have shown the advantage of preselection. Hence, it seems more logical to assume that prior information may facilitate the coding of kinesthetic cues signalling limb position or it may enable the coding of extent into a perceptual reference system other than kinesthetic that is better suited for the retention of extent (Roy, 1978). The obtained results seem to suggest that it could be both. The fact that sighted subjects effectively use preselection to reproduce movement extent indicates that a perceptual reference system like vision is responsible for accurate coding. Also, their ability to counteract biasing effects almost

6.9 completely at short targets indicates that a well integrated kinesthetic-visual system effectively guides these responses. Support to this analysis is also available from O'Connor and Hermelin's (1978) statement that 'for movement in space, visual images seem to have been relevant only when visual experience was very recent' (p. 44). On the other hand, long targets which are mainly dependent on feedback for reproduction are reproduced by the blind group better than their sighted counterparts obviously due to former's skill, experience, and need to develop and refine kinesthetic abilities which the sighted have little reason to practice. A very strong support to this contention has been obtained from relatively superior performance of the blind subjects than those in the sighted group inspite of the biasing effect at the long targets in the constrained condition. Earlier, Kool (1980) also reported such superior performance of the blind subjects on distance reproduction of long targets tested at delayed recall intervals.

The third most noteworthy issue is that the effect of efference will necessarily vary with the external forces on the limbs which are not completely predictable. Therefore, no act however simple (like signing one's name) can be completely preprogrammed. The role of vision is to provide most sensitive information and dominate or recalibrate the proprioceptive system, which is susceptible to drift. But this does not mean that proprioceptive system

6.10 is redundant; for several day-to-day acts are performed without vision. 'Vision is normally used to advantage', writes Lee (1978), 'as a sort of proprioceptive overseer to develop patterns of action and, at the same time, tune the articular proprioceptive system. Actions then can be performed later without visual control, albeit with intermittent checking by vision to correct for drift, their freeing vision for exteroception and exproprioception' (p. 165). In other words, the failure to make use of preselection among the blind people is due to their inability to utilize (a) exteroceptive information which refers to the layout of the environment and about external objects and events, and (b) exproprioception, obtaining information about the position, orientation or movement of the body as a whole, or part of the body, relative to the environment; and not due to proprioception in which, on the contrary, they excel over their sighted counterparts, as has been demonstrated in our studies.

Recent physiological evidence though not very conclusive as yet, indicate that the difference between blind and sighted groups should not be accounted by vision or kinesthesis alone but on the basis of the level of integration of those two systems. Changes in visual input affect involved voluntary activity as well as eliciting of responses to precise stimuli. 'Visual input', remarks Shahani (1979) "has a very significant influence on

6.11 motor system in man ... Reduction in the activity of proximal muscles when visual input is cut suggests that visual input may have a direct effect on cerebellar system ... The reduction in the peak of peak voltage of an averaged 'M' response when stimuli just around threshold level were given in a situation of blindfolding tends to suggest that the state of excitability of a neuron is reflected all along its axon. This opens up an exciting area of enquiry for the future. Similar phenomenon in the reduction of sensory potentials on blindfolding further emphasizes this fact." (p.6). Work of Peterson et al (1971), and others are also cited by him in support.

It is true that visual input influences significantly the motor neuron pool in human beings but when routine learnt movement are being performed the sensory inputs are superfluous. What role vision plays at the behavioural level would be clearly shown in the following example. It has been found that blind people sway about twice as much as normal adults when both were asked to stand with their eyes shut. It means that vision affords the most sensitive information to tune up the other exproprioceptive systems. The reason why congenitally blind subjects fail to use preselection cues is that their nonvisual proprioceptive information is not only poorer than the visual, but at the same time, it is susceptible to considerable drift as was observed in our several experiments in which motor

6.12 distractors were found to cause most deleterious effect on the blind subjects. The only way we could elicit the use of preselection in the blind subjects was when the movements were very short (upto 2 cm, see Chapter 4).

Response Biasing

A general tendency to overshoot a target when the direction of interpolated activity in relation to the criterion movement is pushed forward or vice versa, is characteristic of human movement. Experiments 3.8 and 3.9 have consistently demonstrated this phenomenon. But this effect was attenuated by the sighted group when they were allowed to preselect their responses. What was most interesting was that in forward biasing condition they consistently underestimated long targets - a response feature very much opposed to the biasing effects found in several previous experiments. It clearly shows that preselection represents a conscious mechanism in the control of movement such that effector based information is attenuated. While this type of result goes against corollary discharge hypothesis with no room for accommodating the planning process on the part of the subject, it better fits into a cognitive explanation albeit without making any claim for the likely nature of the encoding strategy itself. It could be that the responses of the subjects in these conditions are influenced

6.13 more by central expectations of sensory input than by the actual input itself (Kelso, 1978).

Conversely, the blind people having failed to derive advantage of preselection depend on their proprioceptive source of information in reproducing the targets and hence fail to attenuate the effects of biasing at both short and long targets. It means that proprioception devoid of vision is influenced by external manipulations but having integration with vision, it provides a stronger base for internalization of a response as is the case with the movement of sighted people.

Prior Activities (PI)

When 2 long and 2 short movements were given prior to the criterion response (Experiment 3.5) the recall of location was affected in both the blind and sighted groups, on the other hand, in recalling distance only the blind subjects were affected but not the sighted. If movement of extent is coded in some nonmotor perceptual store, it is logical to expect the sighted group being unaffected by the PI effect, especially when the subjects were asked to reproduce the last response that was required for learning. The blind subjects also helped themselves but only to a limited extent because there was no further deterioration from 2 prior responses to 4; whereas, a typical PI paradigm predicts greater loss with increase in the number

6.14 of prior activities, as was the case with location task. In other words, once encoding of extent movement is processed at the central level - whether with or without the support of visual reference system - the interfering effects can be attenuated by both blind and sighted people; but if coding is limited to movement based cues only, greater accuracy in terms of its velocity, amplitude, etc are difficult to maintain when interference is caused within the same modality.

From Figure 3.5.9 showing absolute errors, it is clear that the blind and sighted subjects did not differ on zero prior activities of distance task. One possible reason to account it is that they both extrapolated information from prior movements to anchor their responses on this task. Whereas the sighted subjects could achieve better calibration by extrapolation based on prior and standard movements with the support of vision, the blind subjects, based on their limb position information, could do so only without prior activities or at best could save it from damage (to efference copy) upon increase in the number of prior activities by maintaining some access to the central capacity.

Bimodal Effects

While presenting a review of cross modal effects it was mentioned that transfers within the same modality tend

6.15 to augment performance (Millar, 1971; Pick, 1970; Connolly and Jones, 1970; Diewert and Stelmach, 1977). Our results (Experiments 4.4 and 4.5) show that constrained bimodal presentation (tactual + kinesthetic or T-K) tended to help recall accuracy in the sighted group but not in the blind at long targets(which were not really long as compared to other experiments). In fact, the AE data of the blind group showed that their performance was almost consistent in both preselected and constrained conditions of K and T-K conditions. It may be concluded, therefore, that when a sensory modality is sharpened in processing information, additional input like touch in the present case, may not improve performance. On the contrary, if it interferes with the dominant mode of processing, performance may be retarded.

Interpolated Activity

Experiments 3.6, 4.1, 4.2, 4.3 and 4.5 show the effects of interpolated activity on the performance of blind and sighted people. The results bear directly on the coding mechanism of the blind people because when the interpolated activity belonged to a modality in which standard trial was given, i.e., proprioceptive, their performance deteriorated to a great extent as compared to their sighted counterparts. However, data tend to suggest that blind people code proprioceptive information

6.16 effectively in the initial phase, e.g. when recall is obtained from them sufficiently early or immediately, but the stability of codes seems to wither away with both lapse of time and interference.

Target Length

The size of the target was found to be a very sensitive variable throughout the experiments. Although there is nothing very new or unique that has been claimed in the series of experiments reported here, one point which has very vividly emerged out is that spatial representation of blind and sighted people is vastly different; their coding strategies vary depending upon proximity of the targets, and both groups react in their own characteristic sensitivity when extranuous manipulations in the form of response biasing, interference, etc, about which description has already been given in the foregoing paragraphs, are introduced.

It was observed that both blind and sighted groups overshot short targets and undershot long targets but blind people distinguished themselves by making longer responses than the sighted (Experiments 3.1 and 3.2 in pilot study). This tendency may be said to be typical of the blind group.

6.17 Near or far targets seem to be a function of the total operation made by a subject in reaching various targets in an experiment. This happens especially when a subject defines his own targets in the total range of movement as was observed in Experiment 4.4 in which the sighted subjects tended to divide their total movement in terms of psychological space even though the distance travelled was very small. This was shown by the under-estimation tendency normally characteristic of long targets (but actually it is small). In short, when a subject tends to use a plan or strategy, as is the case in preselection, short or long targets are responded to in terms of total adaptation of the range of movements and not by physical criteria alone.

Lastly, it has been envisaged here that short movements are preprogrammed and long ones are guided by feedback. The fact that even blind subjects could use preselection when movement was too short, indicates that encoding of velocity, amplitude, etc are centrally codable and tend to augment performance. For example, commenting on this issue Keele (in press) remarked, "velocity of movement often is tailored to size of the target".

Delayed Recall

Delay in recall is a very sensitive variable for memory. Although loss in motor memory due to delay is

6.18 somewhat different than that for verbal material, it is very clear from almost all the experiments using various recall intervals that when information is held only on the basis of kinesthetic codes, the loss is rapid.

Results reported in the pilot study show how recall of location and distance information was found different in both the blind and sighted groups at 5 and 90 sec delay. Further, when preselection was allowed, the sighted subjects kept their level of performance superior to those in the blind group with delay in recall. Also, both groups differed in their recall accuracy for verbal or movement distractors with lapse of time.

Other effects of delayed recall need not be repeated and the reader is referred to each experiment separately for the specific interaction effects of delay with other variables.

Type of Movement

In all, 3 types of movements were studied - horizontal, vertical and curvilinear. The logic behind studying this variety was that coding of these movements is not identical and that the blind and sighted subjects would differ on these tasks. It has been shown from the obtained results that directionality of movement on linear and curvilinear tasks differ as also the spatiotemporal cues. Blind people

6.19 do not have a sense of verticality and hence code 90° unlike sighted people. Moreover, in a curvilinear task, movement based on distance information causes mismatch to the original movement format and hence affect performance of blind and sighted subjects differently when a comparison was made with that of horizontal or vertical task under identical conditions. It has also been reported that blind people avoid making movements above their head level in vertical space (Hermelin and O'Connor, 1975).

Recent neurological and behavioural evidences seem to suggest that joint receptor information may not differ for linear and curvilinear tasks but dynamics of lengths and tension of opposing muscles may affect performance on these tasks. For instance, on a horizontal task changes in lever mass influenced movement duration in the expected direction by as much as 90 milliseconds, but terminal accuracy was virtually unaffected. On the other hand, unexpected increase in lever mass not only increased movement time but made movement short of the intended location (Keele, in press).

Movement Time

Movement time and reaction time are receiving a great deal of attention from motor memory experts. Our results show that on short targets both blind and sighted performed equally well but with increase in target length movement

6.20 time of the blind group was found shorter than the sighted. It may be due to two reasons. First, since long movements are under feedback control, blind people are able to make better use of their kinesthetic ability and hence are faster. Second, the sighted people continue to depend on help from visual reference system, even though blindfolded, which necessitates programme variations in recalling the target. If this be the case, long movement remains under visual reference control among sighted group. A further possibility is that they slow down speed to bring the limb close to the target and to get final correction depending on visual imagery.

Total time to initiate a movement (Reaction Time) is also important for microscopically analysing the differences between blind and sighted people. Further research is required to study the nature of programming and neurophysiological correlates of timing of movements.

Overloading

Findings reported in Chapter 5 on verbal material clearly indicate that the blind people can retain verbal material much better than their sighted counterparts, especially with delay in recall. This may be due to several reasons: less distraction, better mnemonic skills, or acoustic-perceptual capacity. However, experience from experiment on prior activities (Chapter 3) shows that the

6.21 blind subjects could not bear the effect of prior activities in the distance task and were unable to match the sighted group. It again proves that a motor task interpolated in their motor learning schedule causes deleterious effect in them but this is not so in their verbal learning. It shows that sharpening and articulation of a modality is very important to attenuate the effects of interpolated factors; or else the learner should seek support from some other input to develop an integrated code.

In short, our experiments highlight some very sensitive variables like preselection, prior activities, distractors, location and distance, type of movement, target length, movement time, bimodal stimulation etc in the study of memory of blind people. Most of these issues are relatively poorly explored and very little is known so far about the mysteries of human memory. And this knowledge is still more poorer for the physically handicapped like blind people, who sharpen and articulate their processing system inspite of severe deficiencies. Stressing the need for such type of work, Posner (1978) viewed that importance of modality of input as a basis for selection has been underemphasized by psychologists who base theories primarily on experiments using phenomenological report implying that position in space is interpreted as the tendency of objects to exist at particular locations. Efforts should be made to study modality information as

.22 a tool for selection input, i.e. how people turn their attention to a particular hemisphere, location in the nervous system which is sensitive to a modality, etc, so that information processing capacity could be directly studied. The present work makes a small effort to unfold some latent characteristics of storage and retrieval capacity of blind people.

ON DEFINING GOALS

The reader would have understood by now that the main purpose of this work has been to investigate how informations are received, organized and channelized by the sightless people in their 9^{10} billion live computer housed in a small cranium, the models of which probably will occupy the whole of land if one takes up a gigantic task of analysing total amount of informations that are handled by this small but precious equipment. It is not only important to study the mechanism and processes of this system just for the sake of enrichment of our knowledge but also to explore how best this knowledge can be made useful to improve the quality of life of blind people. Over the years our attitude to the less fortunate group has been based more on compassion and charity than due to appreciation of their talents and a need for having models for our own learning. This attitude has damaged the very roots of a positive approach so essential for rehabilitation and natural growth of any class of people.

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6.23 The humanitarian approach to blind people have had its historical value and no one would deny that it paid its value. All religions of mankind have taught altruistic and compassionate values towards the physically handicapped but those were the days when social rubric was not so complex as we have it now-a-days. With religious values deteriorating, survival of each class of people is becoming extremely competitive and it is essential that each type of people should grow self sufficient, if nothing else, at least economically.

The reasons for not having so far an articulated, sound rehabilitation programme for their welfare have been historical besides lack of scientific analyses. If blind people perform better than sighted - at least in certain tasks - the rehabilitation programs must include those jobs on which they perform adequately to convince not only their employers but also to themselves that they are not some unwanted burden or an odd patch on the colourful fabric of modern society. The demand of their healthy ego development, thus, can be more meaningfully fulfilled in this way.

Attitude of society in general and employers in particular has been a great hurdle in accepting blind people as potential wage earners. It is not surprising, therefore, that a noted industrialist and philanthropist like Vijay Merchant recently remarked that very few

6.24 industrialist responded favourably to his appeal to give more jobs to the physically handicapped. The employers have several misconceptions about employing blind people, as summarized by S. C. Tribhuvan, Employment Officer, Pune:

(i) Thousands of sighted and able-bodied people are available,

(ii) He is completely ignorant of the productive capacities of blind persons - a point which I have been stressing in this report,

(iii) He fears regarding safety of the blind,

(iv) He doubts regarding his mobility, punctuality, and work tolerance,

(v) He also doubts regarding social adjustment, capacity, etc.

But the solution given by this officer is primarily based on an "appeal to the sense of charity of the employer for motivating him to consider the blind person". It is on this point that one has got to be bold and forthright in his approach. Considering the prevailing attitudes, this appeal may sound as practical wisdom, but we have had enough of this approach particularly when we are no more waif-knocking here and there. With access to scientific reasoning and analysis it is not only rewarding to see the role scientific facts play in making others understand what the blind people are capable of but also to develop ways

6.25 and means by which their own potentialities for work in this competitive world are fully realized and put to use. It is, therefore, essential that fundamental research should be encouraged along with applied studies based on researches in ergonomics, bioengineering, psychotechnology, industrial psychology, human engineering, etc. It will be a rewarding policy to integrate such activities along with social work and related welfare activities which are mostly encouraged in the present set up; otherwise, most of our efforts will have only limited impact as was evidenced in the perspective of the employment officer.

A very insightful attempt was made by the Department of Social Welfare, Govt. of India, a few years ago to get meaningful information on several occupations in which various types of physically handicapped people could be suitably employed. The report submitted by the Director of Employment Exchanges, Mr. S. P. Taneja, made a very comprehensive review of 346 occupations with analysis of job description of each one along with its prospects of employment in various sectors/agencies, working conditions, educational and training requirements and suitability/unsuitability to a given handicap. When one glosses over this report microscopically, he is frustrated to find that blind people are found suitable for a very few jobs only. It is true that loss of vision by itself sets limit to enter several vocations but, on the other hand, there is a

great deal of potentiality in them for performing certain jobs very effectively. Highlighting this point, Farrell (1950) wrote :

'Memory still plays an important part in the learning of the blind, although the objective and the motivation differ. The extensive repertoire of many blind musicians and choral groups is a modern illustration of this. The history of the blind abounds with the stories of sightless individuals who have developed phenomenal memories' (p.314).

In Japan, the Govt. had kept many blind persons as a sort of living libraries. They used to commit the events to their memories and repeated them to young blind people in the same establishment for transmission of events from generation to generation. Others have reported that blind people could memorize poetry, poems, etc with phenomenal speed. They have been also used as masseurs in Japan. All this shows that blind people have tremendous potentialities but neither the scientific facts about them are known comprehensively nor the masses enlightened about whatever is already known for adequate exploitation of their unique skills for vocational purposes.

Rather, most people of our society still believe that blindness is a curse and that most blind people deserve only a menial job if at all they are to be given one. Therefore, it is important that besides detailed

6.27 investigations of potentialities, talents and effective modes of adjustment to develop a meaningful programme for vocational rehabilitation of the blind people, education of masses is important on such matters because ultimately not much can be achieved unless people accept them with confidence and truth.

How life in modern society and their own mysery shake the very confidence of blind people is well illustrated from the fact that most of those who lost their sight in later years were fearful and lacked confidence in their ability to navigate alone (Bauman, 1950; Rutberg, 1976). In contrast, the born blind or those with early blindness in life did not show any of these symptoms. 'When the blind person is no longer familiar with his neighbours', writes Rutberg (1976), 'the sense of trust is lost and the sense of isolation increased. Consequently, we find a large number of older blind adults remain indoor' (p.92). In modern city life mobility is high and owing to continuous growth, landmarks also change. In the absence of lack of confidence due to fleating relationships and transience in urban life, orientation and mobility of blind people has become very difficult inspite of whatever proficiency they achieve. Narrating her experience, Rutberg wrote further, 'We notice a blind person, when travelling through an unfamiliar and potentially dangerous situation, demonstrating slower body movements, increased facial and body rigidity, and overall tension' (p.91).

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6.28 Although a lot has been talked about and reported, as a matter of academic exercise, regarding adaptation and proficiency of blind people in changing or unpredictable situations, their problem of mobility training, which is most vital in their life, remains somewhat vaguely explored, nothwithstanding several methods like dog guide, cane use, intensive training, desensitization etc as modes of assistance or training. To meet dangerous situations blind people integrate auditory and tactile stimuli and adjust their orientation and movement in space to cope up effectively. In what way these sensory channels of information are processed and integrated is crucial in determining an orientation and mobility programme of blind people and not just some material assistance (like cane or dog) or mere reduction of stress. It is rather sad to note that the basic knowledge in this effort is quite inadequate, however sincere and honest we claim to be in extracting the very best that is available to us. Besides various programmes for rehabilitation and other philanthropic ways of helping them, the very understanding of the inner world of blind people involves a long, sustained effort which will go a long way to pay rich dividents in future. It is time to respond to this need so as to avoid lags that are likely to confront us in near future.

How much our existing body of knowledge is limited and plagued with confusion on this problem one can judge from

6.29 the fact that researchers not only contradict each other but tend to generalize in almost opposite directions. One such glaring example concerns the ability of blind people to retain auditory information. Although digit span is a very standard and universally acknowledged performance subtest of intelligence (see Chapter 1), in India a very popular intelligence test of Paknikar on blind people has excluded it from the battery of intelligence tests on the ground that it was a very poor measure of blind's ability. Since this aspect refers to the general ability of intelligence which has well founded and universally identified components, the effects of cultural, ethnic or intragroup characteristics in its measurement are ruled out unless some basic sampling errors are committed. The answer to the problem is not simple because it is unfair to comment in one way or the other without conducting a detailed scientific investigation. The reader is referred to some of the findings reported in Chapter 5 without any prejudice on the controversy and he is to make up his mind regarding how the findings get vitiated in the process of over-simplification and what it really means to apply various controls with rigour and matched groups like blind, deaf and normals together. Obviously, it is not the intention here to claim either the superiority of our finding, directly or indirectly, or to denounce the work of others, but simply to suggest that research is a very delicate exercise

6.30 which can be authenticated and made communicable in richness of content and variety. It may become a burden with efforts which are sporadic, piecemeal and discrete. It is unfortunate that there are very few comprehensive and long term studies on specific issues of blindness, a problem on which this country needs to be highly sensitive and responsive more than any other, owing to the fact that we have the highest population of blind people in the world.

It seems that at least two very clumsy, extraneous issues are distorting the overall picture of scientific data that have been collected and interpreted on blind population. One is that the very definition of blindness and criteria to determine it fluctuates from sample to sample or one investigation to another. If one generalizes across several investigations it is really a difficult task, and sometimes impossible, in cases in which loss of vision had varied at different age levels from birth and onwards. In other words, each statement needs to be examined in its longitudinal as well as cross-sectional context before we arrive at a firm explanation.

The second issue relates to the level of analysis adopted for the study of acquisition of behaviour or skill. This aspect is particularly more important than the previous one in which the criteria of defining blindness is known

6.31 both to the researcher and the enterpretor. On the other hand, it is different when one is dealing with the advantage in acquisition of skill arising out of a disadvantage, e.g. less distraction due to blindness, and the proficiency and motivation to overcome the deficit due to blindness by attenuating the distracting effects. To put it more precisely, a sharp distinction should be made between the ability and the effort to acquire a skill efficiently. Inasmuch as this be so, one should not hesitate to accept that a special psychology of blind people is required, much against the claim of those who believe, perhaps, more out of emotion than reason that 'to postulate a special psychology of the blind is only to confuse rather than clarify the issue' (Cutsworth, 1950, p. 174). Scientific reasoning, emotional integration and social planning have entirely different roots and a wise administrator has got to understand the implications of each separately and yet forge them into a practical plan to promote welfare activities. Unfortunately, a lot of imbalance exists and an overall attempt is required in each direction by clearly formulating the policies and programmes for integrated development of blind people.

SUGGESTIONS AND RECOMMENDATIONS

Based on the findings of the present study a number of suggestions can be made for the education, training and rehabilitation of the blind people. This is possible if we

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SUGGESTIONS AND RECOMMENDATIONS

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6.32 clearly identify the nature, purpose and task demands of a educational/vocational programme within the framework of our knowledge of the strength and weaknesses of blind people as an information processor. For illustration purpose, suppose we identify the features of an educational or vocational programme for the blind, e.g. tailoring, knitting, weaving, light machinery jobs, etc. Then the next step would be to answer the following :

- When blind people perform certain tasks proficiently what storage and retrieval processes are characteristic of their performance?
- What conditions could be thought of as optimal for their efficient processing?
- Are they sensitive to specific sources of information? To what extent their processing level is amodal, i.e. information in stimuli which is not tied to specific modalities?
- To what extent can their deficiencies be overcome, e.g. by training, enrichment of environment, stimulation, etc?
- Do they suffer from some developmental lag? If yes, what changes in their training and rehabilitation programmes are required?
- Is it advisable to assume that they would generalize across various similar tasks and keep their performance level high?

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6.33 - Notwithstanding their handicap, in what professions can they compete and excel? What support does one acquire from the obtained empirical data?

Given the abovesaid querries, the most important task now before us is to evaluate the implications of each in the context of visual handicap and to draw viable implications for the acquisition and mastery of various skills in the blind people. Only then the training specialists and prospective employers in particular would realize what they are worth and treat them as a valuable employee without involvement of dependency or compassion.

At the outset everyone concerned with the welfare and training of blind people should realize that they are dealing with a special group and hence, as applied to the memory processes, they should appreciate that MEMORY HAS LIMITED STORAGE CAPACITY AND THIS CAPACITY OF BLIND PEOPLE IS FURTHER LIMITED BY THEIR VISUAL HANDICAP. In other words, only a fixed amount of energy or space is available to handle the input. Given this limitation, the demands of a task become heavier in the blind people because the nature has bestowed a complete, normal human system to operate predominantly with vision.

Short term memory is regarded as buffer system in which information is held for sometime and then lost spontaneously if not properly attended. It means that the

6.34 contents of this system are transitory such that information can be continuously added or deleted in order to meet changing task demands. In fact, it is often referred to as a 'Working memory' because when we deal with a task we retain some part of information to link it later with the following incoming information. Therefore, it may be remarked that TO MAKE RESOURCE POTENTIAL OF THE CONSTRUCT OF SHORT TERM MEMORY SUITABLE TO THE RESOURCE VALUE OF RELEVANT EMPIRICAL TASK, EFFECTS OF VISION MUST BE ELIMINATED.

It is not easy to achieve this goal. To find out how one should go about when a particular vocational skill is to be imparted to a blind person, certain basic procedures and techniques are suggested in this work. Utilizing these paradigms with adequate modifications as per the need, it is not difficult for a instructor to isolate the effects of vision. The whole problem, as we have experienced time and again, is not related to lack of manpower or financial resources to the extent it does to the inertia and drive to achieve the goals that are scientifically examined and verified and to develop an overall scientific culture in the blind institutions to improve operational procedures and methods, job design, development of job aids and training materials, and the selection and training of personnel who would be involved in the use of such items. Since these vary from place to place and institutions to institutions, a massive programme encompassing all such

6.35 problems is not feasible but if some general, basic information is available like the one cited in our several experiments, a trainer can modulate the whole investigation to serve his own specific purpose. In short, it is suggested that A GIVEN PARAMETER OF A JOB BE ISOLATED SO AS TO USE IT AS A DIRECT METHOD OF COMPARISON TO EVALUATE THE PERFORMANCE OF THE BLIND AND SIGHTED PEOPLE. Experiences from our visit to one of the National workshops for the blind is worth narrating in this regard. In the Light Engineering section, we observed that though blind people operated with fair degree of success on a lathe machine, but when it came to strict standards of precision, visual aid was always found necessary. In other words, there are certain jobs on which blind people can extend only supportive role under the direct supervision of the sighted people but this contribution should be of limited nature without involving risk to the individual or loss to the quality of work itself.

Our results have also shown that BLIND PEOPLE LACK PRECISION EVEN IF THEIR TASK IS SELF-SELECTED. This has serious implications for the training of blind people because several voluntary movements, though self-planned, are required to cope with various demands of life. This includes activities ranging from day-to-day activities in the home to some skilled, automated jobs using various gadgets. Comparing these results with location responses

6.36 of the blind people gives somewhat surprising albeit interesting results. In locating targets both blind and sighted groups performed equally well which means that knowledge of spatial lay out is represented in the sighted through vision mainly and in blind through kinesthesis. "To say that location is programmed", writes Keele (in press) in a recent article, "means essentially that a desired ending location can be achieved with no knowledge of starting location, and indeed from a variety of starting points". The results of our experiments conducted as early as in 1977 had showed that this was the case. Based on these findings it is recommended that IT IS FATAL TO EMPLOY THE BLIND IN JOBS IN WHICH LOCATION TARGETS CHANGE FREQUENTLY. A PRIMARY CONSIDERATION IN SELECTING JOBS FOR THE BLIND SHOULD BE THAT THE ENVIRONMENT REMAINS STATIC AND THEIR MOVEMENTS KEPT REPETITIVE AND FIXED SO THAT THEY REACH THE TARGETS CONVENIENTLY.

There is some evidence to support the fact that blind also use preselection (Experiment 4.4) but this is possible only when the targets are very short, probably less than 8-10 cm. This shows that kinesthetically established trace is sufficient information for the blind to be able to retain movements with the same relative efficiency as the sighted. Since such movements are stored in the form of motor programmes it is important that EMPHASIS BE LAID ON DEVELOPMENT OF EFFECTIVE MOTOR PROGRAMMES REQUIRED FOR A TASK.

6.37 Such programmes need (1) establishment of a template corresponding to the skill, (2) execution and movements, (3) use of feedback from the movement and (4) using corrections (for details see Pew, 1966; Holding, 1965; Posner and Keele, 1973).

Skills which do not involve predictable sequences of movement cannot be programmed; for these skills that do, a programme can be constructed and run off as a unit. Such programmes reduce the retention required, become highly automatic and minimize dependence on feedback. A very useful example as to how such programmes develop is cited from the Suzuki technique to teach violin playing. It involves single selection of great,high fidelity music to babies only a few months old. When the same music is played for several months, the children start responding to its effect. At that point another piece is selected. By the age of 3-4 years he is sent to a music school where he learns by ear and certainly not by reading music. The logic of such training is that the child learns how to match the sound produced on the instrument with the auditory templates stored in memory since the time of infancy. In short, acquisition of a motor programme requires storage in memory of a standard or a model of the final skill. Since various visual distractors, which normally retard the performance of the sighted people, do not concern the blind

6.38 people, SKILLS WHICH REQUIRE HIGH DEPENDENCE AND INTEGRATION OF AUDITORY AND KINESTHETIC MODALITIES IN THE BLIND SHOULD BE PROMPTED. IT IS RECOMMENDED THAT MUSIC BOTH AS A LEIZURE AND AS A PROFESSION WILL BE AN IDEAL CHOICE FOR THE BLIND PEOPLE. We already have a few very talented and nationally renowned blind musicians in the country at present and there were several in the past also. It should be also noted that music has a sublimation value and would be helpful in controlling the sexual problems of the blind people, particularly the alarming rate at which they visit the red light areas in the city of Bombay or get used to abnormal quantities of liquor. (This is based on information collected from several blind institutions in Bombay and other cities).

Mobility is an essential but monumental task for the blind people which makes them active to meet various hardships. Music, to that extent, is not challenging and can be rated on the passive side as far as the total body locomotion is concerned. One important way to develop locomotion is aid in the development of articular proprioception through dance, gymnastics, etc (Kooyman, 1970). It is also possible to use ultrasonic devices to provide an exteroceptive aid to the blind people when they perform such skills. Training of exproprioception is possible through uneven surfaces, special shoes, etc. There is no need to mention about mobility training through dog guide, cane, etc because a lot of work

6.39 had already been done and reported from time to time. However, it is important to understand that factors accelerate or limit acquisition of these skills in the blind people.

While examining recall of blind and sighted people on various tasks (Chapter 4) it was found that structural and control factors did not affect their performance uniformly and consistently. In case of the blind people structural limitations obviously refer to visual deficit but control factors refer to operations conducted on the basis of and in response to the input. Our results show that if interference is caused within kinesthetic modality, blind people suffer heavy loss owing to their greater dependence on this modality. This means that INTERFERENCE WITHIN MODALITIES SHOULD BE AVOIDED. Of course, they are in a position to attenuate such effects if recall is obtained sufficiently early or some strategy is used to transfer material from short term store to long term store (Experiment 4.2).

Additionally, a foolproof method to check the impact of control factors is to verify if a deficiency responds to training (Campione and Brown, 1977). If training is unsuccessful, there is high probability that a structural factor is involved. CONTROL DEFICIENCIES ARE, BY DEFINITION, TRAINABLE, WHILE STRUCTURAL FACTORS ARE NOT, AND HENCE TEACHERS OF BLIND PEOPLE SHOULD AIM AT IDENTIFYING THESE DIFFERENCES.

6.40 Three basic components of memory are generally recommended for training people for specific skills: rehearsal, organisational strategies and elaboration. Rehearsal is said to be helpful where the amount of information remembered is very small. Organizational strategies are best suited when the material itself gives some opportunity to relate the items or an individual imposes his own order (subjective organization discussed earlier in Chapter 2). Elaboration strategy is one in which a number of associations between unrelated items are to be learned and when the subject has enough time to do so. The emphasis in each case is to help the learner to generalize across the situations as shown in "learning how to learn" or "plan to use a plan" (Miller, et al, 1960). "The aim of training", writes Campione and Brown, "is ultimately to bring an individual to the point where he can generalize the use of the trained strategy to other tasks having the same type of demands, or at least to maintain the strategy in the same task at a time" (p.374). SINCE BLIND PEOPLE CAN USE REHEARSAL, ORGANIZATIONAL STRATEGIES AND ELABORATION EFFECTIVELY, IT IS RECOMMENDED THAT TRAINING MUST CENTRE AROUND THESE BASIC COMPONENTS SO THAT THEY CAN LEARN ACROSS THE SITUATIONS. This principle as applied to motor learning of blind people, which is so vital for them, means that different specifications such as speed of action, limb position, directionality and size can be applied to a

6.41 representation of motor action more abstract than specific muscles. Since coordinating activity to the demands of a new tasks is constrained by previously learned acts, this would obviously limit the flexibility in arranging body movements to fit a new task and hence make the job of the Instructor more difficult. "One of the major problems in understanding human skill", views Keele (ibid), "is its lack of stereotyping". But then, a lot more can be done within these limitations if we concentrate merely on how best to use the components of memory.

A very sensitive but related issue on the use of memory is the knowledge of metamemorial factors. These factors involve individual's awareness of his own memory processes. He is made aware of it continuously until he himself finds in a commanding position to use his knowledge in some versatile ways, i.e. he becomes aware of using a strategy in various situations (Brown, 1975), but whether this should be done in specific or general ways is being debated. Ignoring these academic differences, the point of interest here is: how would blind people benefit from metamemory factors? When the load of input is increased, particularly when channel capacity limitations are conspicuous, it is difficult for a handicapped person like blind to relate various segments of inputs in his short term limited store and to process them meaningfully at the same time. USE OF METAMEMORY FACTORS WOULD HELP BLIND PEOPLE

6.42 TO MEET THE CHALLENGES ARISING OUT OF OVERLOADED INPUTS. Of course, other advantages of such training are also possible but this seems to be the most significant effect. Since not much work has been done in this area, it is suggested that future research should aim at explaining its further use in the training of blind people.

IT IS VERY IMPORTANT TO KEEP IN MIND THE LEVEL OF MOVEMENT ACCURACY OF VARIOUS TYPES OF MOVEMENTS OF THE BLIND PEOPLE. OUR RESULTS BASED ON THE STUDY OF VERTICAL, HORIZONTAL AND CURVILINEAR MOVEMENTS OF THE BLIND POPULATION HAVE SOME SIGNIFICANT IMPLICATIONS. The author is not aware of any other investigation in which these movements were so extensively studied particularly in the context of the dynamics of motor control and neurophysiology. In the first place, it is highly desirable that BLIND PEOPLE MUST NOT BE GIVEN MANY VERTICAL TASKS WHICH REQUIRE OPERATIONS ABOVE THEIR HEAD LEVEL. There could be several explanations for it: absence of (or very poor) concept of verticality, reluctance to move arm beyond head level and/or poor experience of spatial lay out in the vertical planes (See Chapter 3). Even for the sighted people human engineering experts arrange very few panel control operations beyond head level and in no case those connected with emergency operations. Hence, the sensitivity is obvious for those who are already visually handicapped.

6.43 WHERE DETECTION OF SURFACE CHANGES WITHOUT VISUAL FEEDBACK ARE REQUIRED FOR MANEOUVRING OPERATIONS, BLIND PEOPLE SHOULD BE GIVEN PREFERENCE. Their ability to match the sighted people on the curvilinear tasks in our experiment bears a testimony to it. THUS, JOBS INVOLVING MASSAGE, PHYSIO-THERAPY etc. ARE CONSIDERED USEFUL FOR THE BLIND PEOPLE. It was already reported earlier that in Japan it has been a tradition to employ blind people as masseurs.

IT IS ALSO RECOMMENDED THAT JOBS IN WHICH MOVEMENT OF EXTENT IS REQUIRED FREQUENTLY ON THE HORIZONTAL PLANE ARE NOT SUITABLE FOR THE BLIND PEOPLE.

All types of training and education programmes of the blind people which normally begin from early stages (I am not refering to those becoming blind late in life), should take into account various developmental lags relating to sensory motor coordination, images, cognition, veralism, and so on (reviewed in Chapter 1). Without appreciation of these factors even the best known training and rehabilitation programme may not succeed. In this regard two suggestions are offered. First, sensory development of each modality is not uniform, nor is the levels of integration. Therefore, those who often look for a model development patterns need not be frustrated if a particular deficit is increased or reduced owing to

6.44 presence or absence of a sensory handicap. Also, if sensory processing level of one modality is elaborated and sharpened, simultaneous support from another modality may not benefit but, on the contrary, inhibit performance. Our results of Experiment 4.4 point out to this type of possibility.

A very general programme based on treatment principles involves three stages of development:

Stage I : developing tactile, vestibular, proprioceptive auditory, olfactory and gustatory senses.

Stage II : in relation to body scheme, gross motor learning and integration of the two sides of the body to integrate right and left cerebral hemispheres.

Stage III : to achieve effective perception of spatial lay out both in relation to himself and the objects in the environment.

Analysis of information processing capacity of blind people with reference to touch and movement, their two main sense modalities, enriches our knowledge of the patterns of development. The differences in sensitivity to distractors in blind children and adults reported in Chapter 4 is one of the several examples on which educationists and psychologists have been working in the past few years.

6.45 The second issue relates to the consequence resulting from overuse on a sensory medium. Since braille reading requires fine perception of arrangement of a few small dots in proximity, the tactile acuity should be good. Although the results regarding two-point threshold have not been very uniformly reported in the literature, it appears that the difference in the acuity levels of the blind and sighted people for the same finger is due to constant rubbing of raised points in braille readings. This is true for other senses also. For example, people who work in very noisy conditions suffer a loss of 5 to 10 db in their capacity in about 10 years. WHAT IS IMPORTANT IN THIS CONTEXT IS THAT CHANGES IN THE SENSORY CAPACITY OF THE BLIND PEOPLE IN THE NORMAL DEVELOPMENTAL STAGES AS WELL AS THOSE IMPOSED BY PROLONGED OPERATIONS SHOULD BE IDENTIFIED.

From the experiments reported in this work, their several unique behavioural characteristics have come to light. By and large, the blind subjects tend to make longer responses than their sighted counterparts. Moreover, they also make faster responses for long targets, that is they take less movement time than those in sighted group. Recent data collected in our laboratory for response planning of the blind subjects reveal very interesting information, particularly for those interested in practical consequences and uses in industry in terms of distance, precision and other characteristics. When the reaction

6.46 time data of the blind and sighted subjects was compared on recall of movements on the same horizontal or vertical direction in which the test trial was given, blind subjects were found to show greater response latency than the sighted on both short and long targets with delays of 2 or 30 sec. However, when the recall direction was changed from horizontal to vertical, it was the blind group which gave superior performance in terms of response planning.

It is very encouraging to learn that a wide variety of scientific personnel are busy these days in the study of various properties characteristic of blind people. Their range is really very wide: educationists, psychologists, human engineers/ergonomist, physiologists, physiotherapists, and so on. The trend of research endeavours has also changed now from strictly discipline oriented to interdisciplinary and hence dissemination of ideas has become more fluid than ever before. As such scholars from various disciplines are joining hands together to launch interdisciplinary team researchers. Several results in the present work have drawn the support which ranges from philosophical approaches to some recent discoveries in electrophysiology.

IN VIEW OF THE INTERDISCIPLINARY NATURE OF RESEARCH ON THE PROBLEMS OF BLIND PEOPLE IT IS RECOMMENDED THAT AT LEAST ALL THE BLIND INSTITUTIONS OF NATIONAL REPUTE IN THE

6.47 COUNTRY SHOULD BE GIVEN THE FACILITY TO HAVE A TEAM OF SCIENTISTS CONSISTING OF EXPERIMENTAL/PHYSIOLOGICAL PSYCHOLOGISTS, OPTOMETRISTS, MEDICAL EXPERTS, EDUCATIONISTS, BIOENGINEERS AND COMPUTER TECHNOLOGISTS TO INVOLVE IN JOINT RESEARCHES ON THE PROBLEMS OF BLIND PEOPLE. A VERY GOOD MODEL OF SUCH AN ORGANISATION IS NATIONAL INSTITUTE FOR DEAF AT ROCHESTER, NEW YORK, U.S.A. Only then we will be able to foster a scientific culture which will help in changing the attitudes of people in general and those wanting to help them educationally, vocationally or emotionally in particular. At this point one is tempted to ask: How you can mold your material and guarantee its utility if you yourself do not know the value and content of your material itself? In other words, what more can you do for blind people if your knowledge about them is limited.

Earlier in this report reference was made to the Teneja Committee report on survey for identifying occupations for the physically handicapped on the basis of a proposal by Govt. of India in 1970. It is sad to note that the committee found very few suitable jobs in which the blinds were employed/or could be employed, although this committee covered a large number of occupations (346) and prepared a very comprehensive list. Pursuing this task further, recent reports also have made recommendations on the same lines after survey of several jobs (e.g. 1044 in

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6.48 various categories) BY MAKING PERSONAL CONTACTS AND OBSERVATION OF THE OFFICERS/WORKERS ON THE JOB. Out of the whole list very few jobs like personal assistant, training officer, teacher, packer and stenographer are the only ones which totally blind can perform without help. And yet our doubts remain about their competence in handling these jobs. For instance, the job of a teacher is not simply to lecture on a subject but also to get feedback from the students about their various curricular and extra-curricular activities besides getting direct and instant feedback about presentation of his own material. A few blind teachers may be successful and that too in a limited sense but a majority will have problems. Hence, it is too difficult to convince the employer about accepting a blind person in this job. On the other hand, if it is shown how they excel in music, it is easy for them to understand to have them as teachers. In other words, A JOB CANNOT BE GENERALIZED AS BEING SUITABLE OR UNSUITABLE FOR A BLIND PERSON; ONE HAS TO ANALYSE THE VARIOUS INPUTS IN THE JOB. Thus a teacher's job with high auditory input is suitable for the blind but this may not be true for all types of subjects, e.g. geography. It is believed that more scientific reasoning is required to make a mass appeal in this regard; otherwise, resistance to acceptability of blind people will continue. Even some good work done at the Tata Agricultural and Rural Training Centre for the Blind, or Blind Boys

6.49 Academy of Ramakrishna Mission, Narendrapur, Bengal or excellent suggestions by Mr. Nardekar (1977) for improvements in vocational training and widening its scope may not be widely accepted and adopted.

A PRACTICAL APPROACH

In a rather general way a number of suggestions were given in the above discussion. And yet we remain so far from the problem even after reaching so near to it. When we ask a question whether a blind person is suitable for a job or not, the whole problem boils down to the analysis of the components of a job and the qualities of the person. Moreover, it is also important to consider how the job and the individual will interact together (man-machine system). Some of the problems related to this issue were raised in the preceding paragraphs and specific suggestions were also given but that was only to the extent what was directly or indirectly related to the work reported in this monograph.

It is desirable at this point to take this issue somewhat more broadly. When we analyse the handicaps of people we find that many disabilities are interrelated. The only disability which has little interaction with others is blindness. Therefore, any attempt to over-generalize the physical disabilities is not very proper; in some cases, things which provide assistance to one

.50 disability group may in actuality be an impediment to another (Faste, 1977).

Various jobs in industry require ability to receive information and read displays. In the absence of vision jobs involving visual feedback or detecting fluctuations in illumination, symbolic content, e.g. colour code, picture, map, pictogram, identification labels, etc, legibility, readability, and changing locations would be impossible for them to handle. However, in several jobs they could be absorbed but there would be need to identify the degree of problem associated with those jobs. Such jobs can be classified in 3 categories:

(a) jobs causing potential problems,
(b) jobs causing some problems, and
(c) job causing severe problems.

If we take each job in detail it is not difficult to identify the potentiality of success of a blind person. The following table illustrates this point for several type of tasks; vertical, horizontal, distance, orientation, shape and texture, size, complexity, etc. These illustrations can be easily used to screen the jobs for the blind people and it will not be difficult to convince the employer about the capabilities of blind people if proper publicity is made.

		TOTALLY BLIND	DEAF	LOSS OF UPPER EXTREMITY SKILLS
VERTICAL LOCATION	STRETCH UP	●		●
	REACH UP	▲		●
	MIDDLE RANGE			■
	BEND OVER			·
	KNEEL DOWN	●		·
HORIZONTAL LOCATION	LONG REACH			●
	CLOSE			·
	DISTANCE (EXTENT)	▲		·
SIZE	SMALL			●
	MEDIUM			●
	LARGE			
	CLOSE TOGETHER	▲		●
TEXTURE	SMOOTH	▲		
	TEXTURED			
	SELF SELECTED (PRESELECTED)	■		
COMPLEXITY	OFF / ON			·
	AMODAL	·		
	DISCRETE SETTING	·		●
	CONTINUOUS SETTINGS	●		●
	WITH ACCOMPANYING INSTRUCTIONS	●		
	REQUIRING CONSTANT USE			●
	REQUIRING SIMULTANEOUS ACTIONS	▲		●
LOGIC	ILLOGICAL MEANS OF ACTIVATION	·		
	ILLOGICAL ORIENTATION TO USER	●		
	ILLOGICAL ORIENTATION TO CONTROLLED ITEM	·		
FEEDBACK	VISUAL	●		
	AUDIO		●	
	TACTILE			●
	AUGMENTED			
	TIME LAG	·		
	SENSITIVE CONTROL	●		●
	COORDINATION	·		
MODE OF ACTIVATION	CURVILINEAR			
	SLIDE LEFT OR RIGHT			●
	SLIDE UP OR DOWN			●
	PULL			●

* POTENTIAL PROBLEM
● IMPOSSIBILITY
▲ PROBLEM
■ SEVERE PROBLEM

CONTROL AND INFORMATION DISPLAY PROBLEMS IN PHYSICALLY DISABLED

VERTICAL LOCATION	STRETCH UP	●
	REACH UP	▲
	MIDDLE RANGE	
	BEND OVER	
	KNEEL DOWN	●
HORIZONTAL LOCATION	LONG REACH	
	CLOSE	
	DISTANCE (EXTENT)	▲
SIZE	SMALL	●
	MEDIUM	
	LARGE	
	CLOSE TOGETHER	▲
TEXTURE	SMOOTH	▲
	TEXTURED	
	GRIP SELECTED (PRESELECTED)	●
COMPATIBILITY	OPPOSITION	
	ANGULAR	
	DISCRETE SETTING	●
	CONTINUOUS SETTINGS	●
	WITH ACCOMPANYING INSTRUCTIONS	●
	REQUIRING CONSTANT USE	●
	REQUIRING SIMULTANEOUS ACTIONS	▲
LOGIC	ILLOGICAL MEANS OF ACTIVATION	●
	ILLOGICAL ORIENTATION TO USER	●
	ILLOGICAL ORIENTATION TO CONTROLLED ITEM	●
FEEDBACK	VISUAL	●
	AUDIO	●
	TACTILE	
	AUGMENTED	
	TIME LAG	●
	SENSITIVE CONTROL	●
	COORDINATION	●
MODE OF ACTIVATION	CURVILINEAR	●
	SLIDE LEFT OR RIGHT	●
	SLIDE UP OR DOWN	●
	PULL	●

● POTENTIAL PROBLEM
● IMPOSSIBILITY
▲ PROBLEM
● SEVERE PROBLEM

CONTROL AND INFORMATION DISPLAY PROBLEMS IN PHYSICALLY DISABLED

6.51 From the analysis given in the Table it is clear that laboratory studies often do not in themselves give an obvious or ready-made answer to many situations in which specific behaviour or skill is required but the very effort to use laboratory studies to benefit acquisition of skills for those without vision is no less creative than the myriad efforts which are being made by social workers or politicians. "In recent years" writes Posner and Keele (1973), "The idea of direct applicability of basic research findings has given way increasingly to viewing such results as providing only a very general orientation ....." (p.806). What is implied in our approach is that without enriched knowledge of the various potentialities and limitations of the blind people it would be almost impossible to get suitable jobs for them, satisfy the employer, and change the attitudes of masses.

CONCLUDING REMARKS

The discussion in the foregoing paragraphs seems to have grown so irresolute between different perspectives - scientific reasoning, our results, status of research, employment opportunities, etc that the reader might wonder about the extent of generality and the meaningfulness of projections envisaged. That apart, no one likes mere suggestions but concrete results and firm line of action. Hence, it is desirable to categorically state <u>what</u> has been

6.52 done (or if you permit - achieved) in this work; how effective solutions to problems, e.g. employment, are possible; who can benefit from these recommendations; when should we act; and where more work is possible and dissemination of knowledge required.

(i) As regards what has been done, the aim of the present work was spelled out very vividly right in the beginning. Throughout the work our goal was to study the changes in the memory processes of the blind people at short recall intervals for inputs based on movement, touch and audition. In all the experiments a matched group of sighted subjects was used to examine what role visual reference system can play in changing the course of storage and retrieval processes such that recall is affected by modality specific or amodal factors. Our findings on the effects of preselection, distance, location, prior activities, distractors, bimodal presentation, response biasing and overloading throw a new light on the organization and control processes of memory of blind people.

(ii) Inasmuch as the question of how effective solutions to problem are possible is concerned, the answer is simple. If more work is done on blind people, their hitherto unknown traits will be brought to light and hence their market value is automatically determined. This requires two pronged effort. One is that once a talent is recognized,

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6.53 it spontaneously finds its value with some minor extraneous support. The other relates to minimizing risk and other aversive factors associated with blind people. Enriched scientific knowledge will help both the efforts.

(iii) When should we act? Obviously, the sooner we do, the better it is. It is important to realize that if a lot is being done for able bodied backward people, it is much more needed for the physically handicapped. So long, social work based on welfare policy has immensely benefitted the blind people but now, with change in moral, economic and social values, the need of our time is to gear policies and programmes based on self sufficiency and mutual respect and less emphasis on dependence and compassion.

(iv) Who can benefit? Our approach is that it should be made known that it is not the blind people for whom all this is done, but at the same, it is the employer and the community who are also gaining simultaneously. After all, both industry and community need people who can show exactitude in skills, some of which the blind people can proudly exhibit. Thus, the concept of 'welfare of the blind people' does not reflect all that is contained in the innovative, progressive and equalitarian efforts; rather it remains soggy and hackneyed and invites only pity.

.54 (v) Where more work is possible? The rapid speed with which frontiers of our knowledge are widening is amazing and still more amazing is the rate at which several disciplines are converging on a common platform. In every recent decade virtually a new inter-disciplinary approach has been emerging. It is heartening to note that the kind of research on blind people has also not lagged behind by encompassing the fruitful contributions made in the fields of psychology, sociology, education, bio-engineering, physiology, etc. Instead of keeping these various disciplines separately, as is the conventional pattern in our universities, it is high time that we associate the experts in these areas in institutions of national repute, with a common theme and goal dedicated to various problems of life without vision.

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3.1

APPENDIX 3.I

RAW SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.1

SIGHTED				
	5 sec Retention Interval			
Subjects	Targets (in cm)			
	10	20	30	40
1	-0.2	2.2	0.7	-1.2
2	4.6	0.3	-1.7	+2.2
3	1.0	-1.6	5.4	-5.2
4	3.2	-1.0	0.8	1.8
5	-4.5	-1.2	-5.2	-1.7
6	-5.3	-4.2	-3.7	-4.3
7	3.5	3.5	-4.5	-2.5
8	1.8	-1.6	-1.8	-3.5
9	0.0	6.7	-2.2	0.8
10	1.8	-2.2	1.0	-2.5
11	5.0	0.6	2.0	-0.5
12	3.3	4.0	0.7	2.0
13	0.2	-2.5	-5.5	1.2
14	-1.5	1.5	1.5	-0.5
15	3.2	0.7	1.0	-2.0
16	-2.2	-1.7	-4.0	-3.0
17	1.3	1.5	1.1	0.5
18	4.9	0.6	-1.2	-1.5

Contd.....

3.2

APPENDIX 3.1(CONTD.)

Subjects	20 sec Retention Interval			
	Targets (in cm)			
	10	20	30	40
1	-2.5	-0.5	-2.0	-2.2
2	-1.5	-0.4	-1.2	-0.3
3	-2.0	-3.7	-5.0	-7.5
4	1.5	-3.2	-4.2	0.4
5	2.8	-4.0	2.8	-0.2
6	-3.4	-6.3	-13.1	-4.7
7	1.6	0.0	-8.6	2.2
8	1.5	-6.0	-7.0	-2.5
9	1.8	-0.3	-4.0	+1.2
10	3.0	-2.4	1.4	-7.3
11	5.0	0.2	0.2	-2.0
12	7.0	-1.5	1.2	2.2
13	2.0	-2.5	2.5	1.5
14	2.0	0.2	1.5	-4.5
15	4.5	-0.8	4.0	2.0
16	0.7	2.5	2.5	0.7
17	5.1	4.5	3.0	0.7
18	3.0	1.0	8.5	-0.1

Contd.....

APPENDIX 3.1(CONTD.)

Subjects	Targets (in cm)			
	10	20	30	40
1	-8.3	-0.5	-2.0	-2.8
2	-7.3	-0.4	-1.8	-0.3
3	-8.0	-3.7	-5.0	-7.8
4	1.3	-3.2	-4.2	0.4
5	2.8	-4.0	2.0	-0.2
6	-3.4	-0.3	+13.1	-4.7
7	1.6	0.0	-8.6	2.2
8	1.3	-0.0	-7.0	-2.3
9	1.8	-0.3	-4.0	+1.2
10	3.0	-2.4	1.4	-7.3
11	5.0	0.2	0.3	-2.0
12	7.0	-1.3	1.2	2.2
13	2.0	-2.3	2.3	1.3
14	2.0	0.2	1.3	-4.3
15	4.3	-0.8	4.0	2.0
16	0.7	2.3	2.3	0.2
17	5.1	4.3	3.0	0.7
18	3.0	1.0	2.3	-0.1

Contd.....

3.3

APPENDIX 3.I (CONTD.)

Subjects	90 sec Retention Interval			
	Targets (in cm.)			
	10	20	30	40
1	-1.5	6.0	3.5	-4.0
2	1.8	-0.3	9.5	1.8
3	-1.5	2.5	0.0	2.8
4	-0.8	0.7	-2.4	-4.2
5	10.0	-7.7	0.2	-0.3
6	0.7	-11.5	-15.5	-8.6
7	1.0	8.8	-3.0	3.3
8	-1.6	-2.3	-1.7	-3.5
9	8.7	0.9	-0.2	-0.8
10	3.7	-3.7	-3.0	-8.4
11	3.2	1.7	1.5	-7.5
12	1.0	4.0	4.5	-4.5
13	4.7	-0.5	-0.5	-9.2
14	-0.5	-1.0	8.0	3.0
15	3.5	7.7	2.5	-5.2
16	3.5	-2.8	1.5	-0.8
17	4.0	-2.1	3.8	0.6
18	1.2	4.0	11.2	-3.1

Contd.....

3.4

APPENDIX 3.I (CONTD.)

Subjects	BLINDS			
	5 sec Retention Interval			
	Targets (in cm.)			
	10	20	30	40
1	5.2	3.0	0.5	2.5
2	1.0	2.3	2.0	5.2
3	3.0	0.0	8.5	2.0
4	0.0	6.0	9.0	7.5
5	0.5	-1.6	-3.1	4.5
6	18.0	1.5	8.0	-7.0
7	26.5	14.5	2.5	-8.0
8	3.0	1.0	-1.0	7.0
9	2.2	0.0	-7.5	-2.0
10	0.5	2.3	2.5	1.0
11	3.2	0.1	-4.0	-1.5
12	5.5	7.0	2.0	4.0
13	10.0	10.0	6.0	7.0
14	5.0	5.5	3.5	2.0
15	7.0	-1.0	15.0	0.1
16	7.2	1.0	0.5	2.0
17	3.5	1.1	2.5	3.1
18	3.4	1.8	6.0	1.5

Contd.... ..

3.5

APPENDIX 3.I (CONTD.)

Subjects	20 sec Retention Interval			
	Targets (in cm.)			
	10	20	30	40
1	5.0	5.0	1.3	2.9
2	4.0	14.0	1.3	-2.0
3	10.0	0.0	-4.2	-15.0
4	0.5	12.5	7.5	-9.0
5	0.0	-8.0	8.5	-9.0
6	16.0	0.8	-0.5	1.0
7	19.0	19.0	-2.5	-1.0
8	1.0	6.0	6.3	1.3
9	-2.0	-3.0	-7.0	-1.0
10	5.0	3.0	-7.0	-6.5
11	4.0	3.0	-1.5	-5.0
12	2.0	1.0	4.0	-1.5
13	14.0	11.0	5.5	8.5
14	4.0	5.0	6.0	2.3
15	18.0	25.0	0.0	0.2
16	6.4	1.0	2.1	1.5
17	2.7	0.2	1.5	2.0
18	3.2	16.0	3.8	1.0

Contd... ...

3.6

APPENDIX 3.I (CONTD.)

Subjects	90 sec Retention Interval			
	Targets (in cm.)			
	10	20	30	40
1	7.7	0.2	1.5	7.5
2	6.7	4.5	-3.5	-10.4
3	25.5	10.5	1.0	-3.5
4	3.5	13.0	1.3	19.0
5	-1.5	-6.0	-6.0	-12.8
6	18.0	3.5	0.5	-1.0
7	18.0	15.0	1.0	-20.0
8	-1.0	-2.0	-6.0	9.5
9	-2.0	-12.0	15.5	-5.0
10	6.2	15.5	4.5	-1.0
11	8.0	5.5	0.0	6.0
12	5.8	7.0	-2.0	0.5
13	15.0	0.5	9.0	5.0
14	6.0	3.5	1.5	1.0
15	29.0	9.5	8.0	3.0
16	3.8	5.0	3.8	3.6
17	2.0	3.5	8.0	3.5
18	33.0	10.5	3.4	13.5

3.7

APPENDIX 3.II

RAW SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.1

Subjects	SIGHTED			
	5 sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	-4	5	-5	-3
2	6	4	-2	6
3	5	8	-6	-6
4	7	5	14	13
5	0	-4	-5	12
6	-12	-4	28	-9
7	1	2	14	19
8	3	5	25	15
9	1	2	-1	3
10	3	3	6	10
11	7	0	-1	-2
12	-9	-1	-19	4
13	4	10	6	-10
14	-7	6	-2	2
15	7	5	7	3
16	1	-1	1	1
17	2	3	2	1
18	5	14	-7	1

Contd... ...

APPENDIX 3.II

RAW SCORES OF SUBJECTS ON CONVULSIONS TASK IN EXPERIMENT 3.1

.8

APPENDIX 3.II (CONTD.)

Subjects	20 sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	2	-7	-5	7
2	6	-6	9	-10
3	5	6	13	4
4	7	-1	0	-2
5	5	0	-18	8
6	13	-4	26	-17
7	7	11	-20	0
8	9	-2	-3	4
9	6	-3	-6	-2
10	10	-5	3	-8
11	-3	-1	-4	7
12	5	-3	3	5
13	7	2	-17	-12
14	-5	-5	-5	2
15	3	4	2	19
16	2	-2	2	2
17	3	1	2	1
18	10	15	8	1

Contd... ...

3.9

APPENDIX 3.II (CONTD.)

Subjects	90 sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	-1	-6	-12	13
2	-3	16	16	9
3	4	4	-11	0
4	16	33	0	24
5	-3	-12	-5	0
6	12	5	-60	-37
7	24	8	-48	-44
8	7	-5	12	-6
9	6	5	-2	0
10	12	13	-10	-24
11	9	-5	-14	-8
12	2	10	-3	-8
13	22	20	-35	-35
14	6	19	-27	-14
15	3	51	7	7
16	0	-8	-11	-7
17	9	3	2	-8
18	16	59	7	16

Contd... ...

3.10

APPENDIX 3.II (CONTD.)

BLIND

Subjects	5 Sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	17	-10	-5	-4
2	4	2	12	3
3	55	33	7	12
4	5	-5	-17	-7
5	0	10	30	-5
6	15	-2	15	-6
7	115	53	-10	10
8	12	12	-15	0
9	-2	-8	-10	5
10	11	-1	-20	9
11	14	8	-10	-1
12	10	25	8	25
13	10	11	3	20
14	5	10	-15	15
15	15	40	40	5
16	6	2	8	12
17	3	4	2	5
18	-1	-5	-5	6

Contd... ...

APPENDIX 3.II (CONTD.)

BLIND

5 Sec Retention Interval

Subjects	Targets (in Deg.)			
	30	90	120	240
1	17	-10	-5	-4
2	4	2	12	3
3	55	33	7	14
4	5	-5	-17	-7
5	0	10	30	-5
6	15	-2	15	-6
7	115	33	-10	10
8	12	12	-15	0
9	-2	-8	-10	5
10	11	-1	-30	9
11	14	8	-10	-1
12	10	25	8	25
13	10	11	3	20
14	5	10	-15	15
15	15	40	40	5
16	6	2	8	12
17	-3	4	2	3
18	-5	-5	-5	6

Contd... ...

3.11

APPENDIX 3.II (CONTD.)

Subjects	20 Sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	14	-10	-5	-6
2	10	+15	35	-2
3	62	60	38	-5
4	20	20	-5	-4
5	3	2	-2	-5
6	4	50	-3	-24
7	105	45	13	8
8	18	-10	33	-4
9	-1	0	-35	-6
10	25	15	-14	12
11	-2	-3	5	-10
12	17	20	22	15
13	20	20	-5	7
14	10	6	3	20
15	32	40	3	2
16	18	17	4	14
17	2	12	5	10
18	1	3	25	5

Contd... ...

3.12

APPENDIX 3.II (CONTD.)

Subjects	90 Sec Retention Interval			
	Targets (in Deg.)			
	30	50	120	140
1	35	52	20	5
2	109	43	-10	13
3	135	115	36	-22
4	25	23	-42	-5
5	25	11	2	18
6	0	-5	-5	-91
7	120	100	3	-3
8	6	25	12	29
9	2	-8	-15	22
10	23	96	30	23
11	20	14	5	6
12	17	5	5	10
13	140	20	2	10
14	30	10	30	16
15	135	10	-20	20
16	6	6	30	20
17	52	24	14	5
18	1	3	29	30

Subjects	90 Sec Retention Interval			
	Targets (In Deg.)			
	30	90	120	180
1	35	32	20	3
2	109	43	-10	13
3	135	115	36	-22
4	25	23	-22	-3
5	25	11	2	12
6	0	-5	-5	-21
7	120	100	3	-3
8	6	25	12	29
9	2	-8	-15	-22
10	23	96	30	43
11	20	14	5	6
12	17	5	3	10
13	140	20	2	16
14	30	10	30	16
15	135	10	-20	20
16	6	6	30	20
17	32	24	14	3
18	1	3	29	30

.13

APPENDIX 3.III

RAW SCORES OF SUBJECTS ON HORISONTAL TASK IN EXPERIMENT 3.2

SIGHTED

Information	Subjects Sl.No.	Targets (in cm.)				
		10	15	20	25	30
Simple Reproduction	1	0.6	-0.5	-0.5	-1.3	-1.1
	2	0.8	-1.8	1.6	-1.8	-2.4
	3	1.2	1.0	-1.0	-3.0	-1.8
	4	-0.6	-0.2	-0.8	-1.2	-2.2
	5	4.3	-1.0	-1.6	-1.5	0.3
	6	-1.0	1.0	-1.8	-4.2	0.6
	7	0.0	-1.0	-1.5	-1.8	-2.5
	8	1.2	1.8	-3.5	-4.0	-3.0
	9	1.5	0.0	-5.0	-2.0	-2.0
	10	1.1	-1.0	-0.5	-0.3	-3.0
Location	1	1.6	1.2	0.8	1.6	0.6
	2	0.6	1.3	1.2	0.0	1.8
	3	1.0	1.6	1.0	1.0	3.2
	4	1.1	-0.5	-0.8	-2.0	-1.5
	5	2.0	-1.3	1.0	-0.1	0.4
	6	0.5	1.5	-1.0	-2.1	-2.5
	7	0.4	0.5	1.0	-1.2	-2.2
	8	0.5	1.5	2.5	0.6	-0.8
	9	0.0	0.1	-0.2	-1.5	0.4
	10	0.0	0.6	1.0	0.0	0.0

Contd..

RAW SCORES OF SUBJECTS ON NONSENSICAL
TASK IN EXPERIMENT 3.2

Information	Subjects Sl.No.	Targets (in cms.)			
		10	15	20	25	30
Simple Reproduction	1	0.6	-0.5	-0.5	-1.3	-1.1
	2	0.8	-1.8	1.6	-1.8	-2.4
	3	1.4	1.0	-1.0	-3.0	-1.5
	4	-0.6	-0.2	-0.8	-1.2	-2.2
	5	4.3	-1.0	-1.6	-1.5	0.3
	6	-1.0	1.0	-1.8	-4.2	0.4
	7	0.0	-1.0	-1.5	-1.8	-0.3
	8	1.2	1.8	-3.3	-4.0	-3.0
	9	1.5	0.0	-3.0	-2.0	-2.0
	10	1.1	-1.0	-0.3	-0.3	-2.6
Location	1	1.6	1.2	0.8	1.6	0.6
	2	0.6	1.3	1.2	-0.3	1.8
	3	1.0	1.6	1.0	1.0	0.6
	4	1.1	-0.5	-0.8	-2.0	-1.3
	5	2.0	-1.3	1.0	-0.1	0.4
	6	0.3	1.3	-1.0	-2.1	-2.3
	7	0.4	0.3	1.0	-1.3	-2.2
	8	0.3	1.5	2.3	0.6	-0.3
	9	0.0	0.1	-0.3	-1.3	0.4
	10	0.0	0.6	1.0	0.0	0.0

3.14

APPENDIX 3.III (CONTD.)

Information	Subjects Sl.No.	Targets (in cm.)				
		10	15	20	25	30
Distance	1	0.3	-1.7	-2.5	-2.4	-6.5
	2	1.7	2.5	3.0	-5.0	-4.8
	3	0.8	1.2	1.2	-1.2	-1.2
	4	-3.2	2.0	-1.9	-4.0	-8.2
	5	4.6	1.5	-3.0	-4.2	-9.5
	6	-1.4	-3.0	-4.0	-6.5	-8.0
	7	2.8	-4.5	-5.0	-5.0	-7.0
	8	1.2	3.5	-3.1	-4.5	-7.5
	9	-0.2	0.2	2.0	-6.5	-7.8
	10	1.8	1.5	-3.0	-4.0	-7.5
		BLIND				
Simple Reproduction	1	-0.5	-1.0	-1.0	-3.5	-5.5
	2	1.0	3.5	5.5	1.0	5.0
	3	5.6	4.0	5.5	6.5	3.5
	4	2.0	0.7	0.0	0.5	-0.5
	5	0.8	2.5	1.2	-0.5	2.5
	6	0.0	1.5	-1.2	-3.0	-1.5
	7	1.0	2.0	1.0	-0.5	-1.2
	8	3.0	2.5	3.0	7.5	0.7
	9	4.0	0.5	1.5	-1.0	-2.0
	10	-0.8	-3.0	-2.5	1.0	-2.2

Contd.. ..

3.15

APPENDIX 3.III (CONTD.)

Information	Subjects Sl.No.	Targets (in cm.)				
		10	15	20	25	30
Location	1	-0.2	-1.0	-3.5	-1.7	-4.5
	2	-0.1	3.5	0.2	0.1	-2.0
	3	3.5	5.0	3.0	2.5	5.0
	4	0.8	4.5	2.5	3.5	1.5
	5	1.5	3.0	2.0	3.5	4.0
	6	2.5	3.5	3.2	2.5	0.8
	7	3.0	2.5	0.8	2.0	3.0
	8	4.0	4.0	5.0	6.0	4.5
	9	5.5	3.5	3.5	0.5	5.0
	10	2.5	1.2	0.5	0.5	-2.0
Distance	1	-0.5	-2.0	-4.5	-7.5	-5.0
	2	1.2	0.5	-6.4	-1.0	-9.0
	3	9.5	5.0	0.6	1.5	4.0
	4	4.0	2.5	2.0	-2.5	-4.0
	5	-1.0	3.5	-6.0	-3.0	-4.6
	6	10.0	4.5	-2.5	2.5	-5.5
	7	8.5	8.0	3.0	0.0	-1.0
	8	4.5	8.5	4.0	-1.0	2.5
	9	12.0	11.0	5.0	0.5	3.3
	10	0.1	-2.5	-3.0	-4.5	-10.0

3.16

APPENDIX 3.IV

ERROR SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.2

SIGHTED

Information	Subjects Sl.No.	Targets (in cm.)				
		10	15	20	25	30
Simple Reproduction	1	0.5	-0.9	-0.3	2.5	-0.2
	2	-0.5	-0.3	-1.5	-0.2	4.5
	3	-0.2	-0.6	-2.2	-3.0	-0.7
	4	-0.3	0.7	-2.5	-3.0	-5.8
	5	-0.3	1.5	0.0	1.0	-7.0
	6	0.0	-1.0	1.6	-2.8	-2.9
	7	0.8	-1.0	2.5	-3.5	-4.5
	8	-1.0	-1.5	-3.0	-3.7	-4.0
	9	0.4	0.9	0.2	-2.5	0.5
	10	-0.5	-1.0	1.0	0.0	2.8
Location	1	1.0	1.0	2.0	1.5	-1.0
	2	2.3	0.0	1.0	-0.5	-1.1
	3	1.0	1.0	0.1	0.8	2.8
	4	-0.5	0.0	-1.0	-2.5	-3.8
	5	0.0	0.7	1.7	-2.0	-1.1
	6	1.7	1.2	0.2	1.5	-2.0
	7	0.5	1.5	2.0	-2.2	-3.5
	8	1.5	2.0	2.5	-2.5	-3.0
	9	-0.1	1.2	1.0	-2.5	-0.4
	10	0.8	1.2	1.5	-1.4	-2.0

Contd.....

APPENDIX 3.IV

ERROR SCORES OF SUBJECTS ON VERTICAL TASK

IN EXPERIMENT 3.2

Information	Subjects Sl.No.	Targets (in cm.) 10	15	20	25	30
Simple Reproduction	1	0.5	-0.9	-0.3	-2.3	-0.2
	2	-0.5	-0.3	-1.5	-0.2	[illegible]
	3	-0.2	-0.6	-2.2	-3.0	-0.7
	4	-0.3	0.7	-2.5	-3.0	-3.5
	5	-0.7	1.5	0.0	1.0	-7.0
	6	0.0	-1.0	1.6	-2.8	-2.9
	7	0.8	-1.0	2.5	-3.5	-4.2
	8	-1.0	-1.5	-3.0	-3.7	-4.0
	9	0.4	0.9	0.2	-2.3	0.5
	10	-0.5	-1.0	1.0	0.0	2.6
Location	1	1.0	1.0	2.0	1.5	-1.0
	2	2.3	0.0	1.0	-0.5	-1.1
	3	1.0	1.0	0.7	0.8	0.8
	4	-0.5	0.0	-1.0	-2.5	-3.0
	5	0.0	0.7	1.7	-2.0	-1.3
	6	1.7	1.2	0.2	1.5	-2.0
	7	0.5	1.5	2.0	-2.2	-0.5
	8	1.5	2.0	2.5	-2.5	-3.0
	9	-0.1	1.2	1.0	-2.5	-0.4
	10	0.8	1.2	1.5	-1.4	-2.0

Contd.....

3.17

APPENDIX 3.IV (CONTD.)

Information	Subjects Sl.No.	Targets (in cm.) 10	15	20	25	30
Distance	1	0.0	7.6	-1.0	-4.2	-0.5
	2	4.0	0.1	3.0	1.5	2.5
	3	-1.0	-1.0	-3.8	-3.8	-3.2
	4	-2.0	-2.0	-3.8	-6.0	-7.0
	5	1.0	-3.5	-2.1	-5.2	-10.0
	6	1.2	-1.0	3.0	-6.5	-8.0
	7	2.5	-3.0	3.5	-5.0	-6.0
	8	2.2	-3.5	3.5	5.5	-7.0
	9	5.2	1.5	-1.0	4.5	5.5
	10	1.9	2.0	2.5	-3.0	-5.0
	BLIND					
Simple Reproduction	1	-1.5	0.5	1.5	0.0	0.0
	2	-0.5	0.3	-0.8	-1.0	1.7
	3	1.0	-0.5	0.0	0.5	-0.5
	4	-0.2	-0.5	1.0	2.0	2.5
	5	6.0	3.0	4.0	0.6	1.6
	6	-0.2	-0.5	-1.2	0.1	2.0
	7	1.0	2.5	3.6	4.5	5.0
	8	2.5	2.0	2.5	2.0	1.5
	9	5.0	3.0	1.8	2.5	1.0
	10	-1.5	-2.0	-4.5	-3.5	1.0

Contd.....

3.18

APPENDIX 3.IV (CONTD.)

Information	Subjects Sl.No.	Targets (in cm.)				
		10	15	20	25	30
Location	1	-1.0	-1.0	-0.5	0.0	0.5
	2	1.2	1.8	0.5	1.3	-2.8
	3	1.0	0.4	-0.2	1.2	2.0
	4	-0.6	4.5	3.6	-0.8	-1.7
	5	5.0	1.6	8.8	-3.7	10.0
	6	2.8	1.5	0.7	5.5	-0.5
	7	2.5	2.6	2.5	3.0	1.0
	8	2.5	3.2	4.5	4.5	5.0
	9	3.3	5.0	1.3	0.8	4.0
	10	3.0	-0.5	0.0	0.5	2.0
Distance	1	-1.2	-1.2	-2.0	-4.5	-6.5
	2	5.0	-2.0	-2.0	-9.0	-11.0
	3	-3.2	-5.0	-4.0	-5.7	-10.0
	4	1.0	3.0	2.0	-6.5	-7.0
	5	2.0	7.0	0.0	-1.0	-6.5
	6	2.3	0.7	-0.8	-6.5	-5.0
	7	3.5	3.5	2.5	-2.0	2.0
	8	4.0	4.0	-1.0	-3.5	6.0
	9	10.0	2.8	4.0	-1.0	-3.0
	10	1.0	-3.0	-2.9	-2.1	-6.1

3.19

APPENDIX 3.V

ERROR SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.2

SIGHTED						
Information	Subjects Sl.No.	Targets (in deg.)				
		30	50	70	90	110
Simple Repreduction	1	0	-7	-10	-4	-10
	2	-8	7	1	-5	- 2
	3	0	6	5	6	- 5
	4	-3	3	6	5	- 2
	5	2	-9	-15	-5	- 1
	6	9	0	15	8	-10
	7	0	-5	- 7	-8	1
	8	2	-12	-3	0	1
	9	-4	-9	-5	0	5
	10	1	-1	3	3	- 6
Location	1	3	2	-5	-4	- 2
	2	2	6	2	1	3
	3	5	4	7	6	2
	4	3	0	2	0	0
	5	9	5	6	-2	0
	6	6	2	12	-2	13
	7	1	4	-6	2	2
	8	10	3	3	5	5
	9	1	9	-1	-11	0
	10	6	5	6	-5	3

Contd....

APPENDIX 3.V (CONTD.)

Information	Subjects Sl.No.	Targets (in deg.)				
		30	50	70	90	110
Distance	1	10	12	-5	-10	-15
	2	11	12	-5	-28	-36
	3	0	- 2	-7	11	- 1
	4	0	- 9	-23	-30	-14
	5	2	10	10	- 8	- 7
	6	1	7	- 6	-15	- 5
	7	13	-10	-12	-15	-20
	8	17	8	5	0	-15
	9	1	15	-11	-15	- 4
	10	13	5	1	-13	-25
	BLINDS					
Simple Reproduction	1	2	0	-3	-2	- 5
	2	1	-2	-7	-17	-29
	3	2	-2	-8	-7	-7
	4	-4	1	-8	-2	5
	5	8	2	16	-4	5
	6	-1	0	7	-1	-5
	7	-3	0	-5	-4	6
	8	-6	-5	-15	-11	-12
	9	-2	7	-24	5	10
	10	-11	-2	-12	5	-11

Contd....

APPENDIX 3.V (CONTD.)

Information	Subjects Sl.No.	Targets (in deg.)				
		30	50	20	90	110
Location	1	0	1	-4	-1	-2
	2	-10	-12	-19	-6	-8
	3	5	1	-7	-2	-13
	4	6	5	9	2	-4
	5	-4	6	4	0	3
	6	1	-1	-4	-26	-25
	7	-2	-7	-5	-18	-18
	8	6	6	20	22	25
	9	8	32	11	-7	-14
	10	1	4	-4	2	-5
Distance	1	5	5	8	15	-3
	2	6	7	-2	14	1
	3	0	16	15	2	14
	4	-2	-4	-2	1	-3
	5	12	17	4	-5	-5
	6	9	4	21	-2	-1
	7	35	-19	22	3	40
	8	5	10	-15	-24	-27
	9	55	38	20	-10	-15
	10	5	9	15	-10	-22

3.22

APPENDIX 3.VI

RAW SCORE OF SUBJECTS ON HORIZONTAL TASK OF EXPERIMENT 3.3

SIGHTED

Information	Retention interval	Subjects Sl.No.	Targets (in cm.) 6				
			10	15	20	25	30
Location	5 sec.	1	0.5	-2.0	-3.5	-4.0	+3.0
		2	-0.2	-0.2	0.2	1.0	-2.5
		3	0.5	0.6	0.2	-1.0	-2.0
		4	0.0	0.6	-1.3	-1.0	-3.0
		5	0.7	-0.5	2.0	-0.7	0.5
	20 sec.	1	-1.0	-2.0	-4.0	-4.0	-4.5
		2	-0.7	0.8	1.8	-2.0	1.6
		3	-0.2	-0.2	-0.5	0.9	-3.0
		4	0.0	-2.2	0.0	-1.0	-2.9
		5	-0.7	0.5	4.5	3.6	-0.2
	90 sec.	1	+2.5	+3.5	-2.0	+3.0	-4.0
		2	-1.6	0.0	2.2	1.4	1.7
		3	0.0	0.5	1.5	-0.8	1.9
		4	0.0	-1.0	1.5	-2.0	-2.7
		5	1.5	2.0	-0.5	6.5	-1.0
Distance	5 sec.	1	2.0	1.5	1.8	-3.5	-4.8
		2	1.7	-1.5	-1.5	-1.5	-2.5
		3	-2.7	-3.0	1.6	-3.6	-5.4
		4	-1.3	0.8	-1.3	-4.0	-2.5
		5	1.6	3.0	-2.8	3.0	-4.6

Contd....

3.23

APPENDIX 3.VI (CONTD.)

Information	Retention interval	Subjects Sl.No.	Targets (in cm.)				
			10	15	20	25	30
	20 sec.	1	-2.2	-2.4	2.5	-6.5	-10.5
		2	-3.2	2.0	-3.5	-1.5	-4.0
		3	-0.6	-0.5	-2.4	-2.3	-1.9
		4	0.2	1.0	-2.9	-10.0	-7.3
		5	2.4	3.2	2.8	-5.3	-4.5
	90 sec.	1	-6.2	-2.5	-3.5	-6.5	-9.9
		2	-4.5	-5.0	-5.0	-6.5	-2.8
		3	-2.7	-2.6	-2.9	-8.5	-8.6
		4	-0.4	-1.6	-4.3	-4.8	-11.8
		5	3.6	-2.6	-1.8	-4.3	-1.0
		BLIND					
Location	5 sec.	1	3.0	0.8	2.2	1.8	0.3
		2	2.0	-1.5	6.5	3.0	2.7
		3	7.5	2.5	1.5	0.7	2.5
		4	0.5	0.0	0.5	2.5	2.5
		5	4.5	4.0	6.5	0.0	5.5
	20 sec.	1	0.2	-1.0	6.5	-2.5	-2.5
		2	3.2	3.2	1.7	2.5	1.3
		3	0.8	5.0	4.0	3.5	2.5
		4	-0.2	2.4	0.0	2.0	1.0
		5	2.2	2.7	2.0	5.0	3.0

Contd....

3.24

APPENDIX 3.VI (CONTD.)

Information	Retention interval	Subjects Sl.No.	Targets (in cm.) 10	15	20	25	30
	90 sec.	1	2.5	1.0	1.3	0.0	6.0
		2	-0.3	12.0	5.0	1.5	-0.5
		3	4.0	3.0	2.5	3.5	6.0
		4	2.0	6.5	-3.0	-0.2	5.5
		5	2.5	8.5	4.4	6.5	8.0
Distance	5 sec.	1	9.0	6.5	6.0	4.0	1.5
		2	0.5	-1.0	2.0	-2.0	-2.0
		3	3.5	4.0	0.0	8.0	-3.5
		4	1.0	-1.0	-1.5	-3.5	3.5
		5	11.0	7.5	1.5	5.5	-5.0
	20 sec.	1	2.0	9.5	5.0	7.5	-5.0
		2	-2.0	0.0	1.0	1.5	2.2
		3	2.3	-0.5	3.5	2.5	2.0
		4	8.0	2.5	1.5	-3.8	-10.0
		5	7.0	1.5	9.0	-0.4	-4.5
	90 sec.	1	6.5	7.5	8.0	6.5	1.0
		2	0.5	6.0	-1.2	-4.0	2.0
		3	4.0	6.0	6.0	3.0	-0.4
		4	12.0	2.0	-7.5	-3.0	-8.5
		5	8.0	10.0	9.0	8.0	-5.0

3.25

APPENDIX 3.VII

RAW SCORES OF SUBJECTS ON VERTICAL TASK OF EXPERIMENT 3.3

SIGHTED

Information	Retention interval	Subjects Sl.No.	Targets (in cm.)				
			10	15	20	25	30
Location	5 sec.	1	-0.7	-1.4	-1.8	-2.5	-1.0
		2	0.5	-1.2	0.6	-1.4	-1.5
		3	0.0	0.4	0.2	0.9	1.1
		4	1.7	0.0	0.6	0.6	1.6
		5	-1.3	-0.9	0.5	0.6	-1.8
	20 sec.	1	-0.6	-0.3	-1.3	-1.5	-3.6
		2	0.0	-0.6	-1.0	1.5	-3.3
		3	0.0	0.1	1.5	2.0	2.5
		4	-0.5	-0.2	0.7	-2.3	-3.6
		5	-0.4	2.7	-0.7	-1.0	-3.0
	90 sec.	1	1.5	-1.3	-0.5	0.0	-2.0
		2	0.0	0.4	-2.0	0.0	-3.0
		3	0.1	-0.6	3.0	2.3	2.2
		4	1.2	1.0	-1.7	-0.1	-4.5
		5	-1.0	-1.2	-0.9	-1.6	-1.6
Distance	5 sec.	1	1.7	1.5	-3.0	-3.5	-3.5
		2	1.0	1.5	2.0	2.0	-2.0
		3	-0.6	1.5	4.0	0.0	5.0
		4	1.7	-0.8	-3.2	7.5	-6.4
		5	0.2	0.3	-1.1	-4.0	-8.0

Contd.....

3.26

APPENDIX 3.VII (CONTD.)

Information	Retention interval	Subjects Sl.No.	Targets (in cm.)				
			10	15	20	25	30
	20 sec.	1	3.5	-2.5	-3.0	-4.5	-8.8
		2	2.1	3.0	0.0	3.2	2.5
		3	-0.5	2.5	0.5	0.8	3.0
		4	-0.5	-2.2	3.0	-5.0	-9.5
		5	3.4	-0.2	-1.3	-6.5	-7.0
	90 sec.	1	-5.0	-4.5	-7.5	-8.5	-12.6
		2	2.5	5.5	3.0	-4.0	3.5
		3	-1.0	0.5	-4.0	10.0	-10.6
		4	0.0	-1.2	-2.8	-4.7	-10.0
		5	2.2	-1.0	-8.0	-6.5	-7.6
		BLIND					
Location	5 sec.	1	-1.1	-1.4	-1.5	-3.5	-1.5
		2	1.3	-0.6	0.4	0.1	-1.6
		3	0.0	0.7	-3.5	-1.8	-2.5
		4	3.0	-1.0	-1.5	1.5	-1.2
		5	2.8	6.0	5.5	3.5	9.0
	20 sec.	1	3.0	-0.3	-2.5	-4.2	-0.4
		2	-0.2	0.2	0.3	5.3	0.0
		3	1.0	-0.2	-0.8	1.2	-3.8
		4	3.0	-1.2	1.0	0.0	-6.0
		5	2.0	4.0	0.0	8.5	7.5

Contd...

3.27

APPENDIX 3.VII (CONTD.)

Information	Retention interval	Subjects Sl.No.	Targets (in cm.)				
			10	15	20	25	30
	90 sec.	1	3.2	0.2	-1.8	-2.0	-6.0
		2	0.5	6.5	1.5	1.6	3.8
		3	1.5	0.0	0.8	-2.1	-4.5
		4	5.5	2.0	-0.8	-5.0	-4.0
		5	5.0	3.0	6.0	1.5	0.0
Distance	5 sec.	1	4.0	7.0	-1.5	-3.5	-4.0
		2	5.1	3.5	5.5	1.7	-3.5
		3	4.0	2.5	4.5	-0.8	2.0
		4	6.5	3.5	-1.5	0.5	10.0
		5	14.0	2.0	5.5	-2.5	1.0
	20 sec.	1	1.3	0.5	0.8	-5.5	-7.0
		2	3.5	0.0	1.5	2.5	-0.5
		3	0.5	-3.5	1.5	6.5	3.5
		4	4.3	4.5	-3.5	-3.3	-5.0
		5	10.0	8.0	11.0	3.0	-1.2
	90 sec.	1	4.5	-1.5	0.2	-2.5	-5.0
		2	4.0	0.5	0.7	1.5	0.2
		3	0.6	2.5	9.0	4.5	5.5
		4	6.8	-1.5	1.5	-6.7	-5.5
		5	15.0	12.0	10.0	9.5	4.0

3.28

APPENDIX 3.VIII

RAW SCORES OF SUBJECTS ON CURVILINEAR TASK OF EXPERIMENT 3.3

SIGHTED

Information	Retention intervals	Subjects Sl.No.	Targets (in deg.)				
			30	50	70	90	110
Location	5 sec.	1	3	6	8	-3	9
		2	2	7	-5	2	-7
		3	2	2	4	-1	-1
		4	4	5	-2	4	-6
		5	1	-1	-1	8	-2
	20 sec.	1	1	5	-4	0	9
		2	0	-5	-6	-1	-3
		3	1	-4	-3	1	5
		4	5	-2	1	2	-8
		5	-1	-1	-1	6	-4
	90 sec.	1	-3	8	0	3	-1
		2	-5	-7	-3	0	-3
		3	6	-5	-5	-7	-5
		4	2	4	-4	-11	-9
		5	11	0	-2	-5	-5
Distance	5 sec.	1	10	-3	15	-10	-10
		2	8	11	7	-17	-5
		3	8	-8	6	2	-6
		4	4	12	-12	-7	-32
		5	19	9	13	-2	-17

Contd....

3.29

APPENDIX 3.VIII (CONTD.)

Information	Retention intervals	Subjects Sl.No.	Targets (in deg.)				
			30	50	70	90	110
	20 sec.	1	5	12	4	10	19
		2	15	-4	7	-18	-19
		3	19	14	0	-12	20
		4	-2	3	3	6	-28
		5	12	-1	6	-4	-27
	90 sec.	1	12	15	5	-2	-27
		2	17	6	10	-22	-15
		3	3	34	-27	20	-23
		4	0	-7	0	0	-12
		5	10	7	5	-8	-8
		BLIND					
Location	5 sec.	1	-4	-4	-4	4	-15
		2	2	-3	8	-7	-17
		3	15	-2	3	10	8
		4	3	5	-2	-1	-22
		5	7	5	0	-2	-4
	20 sec.	1	-4	-3	5	-2	-21
		2	1	-2	-3	-8	-13
		3	11	8	3	5	-6
		4	14	-12	-8	-9	-4
		5	11	-4	3	-3	-12

Contd.....

Information	Retention Interval	Subjects Sl.No.	Percentile (In deg.)			
			25	50	75	90
	20 sec.	1	5	12	4	19
		2	15	-4	7	-18
		3	19	14	0	-12
		4	-4	3	3	6
		5	12	-1	6	-4
	90 sec.	1	12	15	5	-4
		2	17	6	10	-22
		3	3	24	-27	20
		4	0	-7	6	0
		5	10	7	5	-8
				BLIND		
Location	5 sec.	1	-4	-4	-4	A
		2	2	-3	8	-4
		3	15	-4	3	10
		4	3	5	-4	-1
		5	7	5	0	-4
	20 sec.	1	-4	-3	5	-4
		2	1	-4	-3	-8
		3	11	8	3	5
		4	14	-12	-3	-4
		5	11	-4	3	-3

Contd.....

3.30

APPENDIX 3.VIII (CONTD.)

Information	Retention intervals	Subjects Sl.No.	Targets (in deg.)				
			30	50	70	90	110
	90 sec.	1	10	4	0	-11	-12
		2	3	3	4	8	-17
		3	22	20	13	-5	2
		4	10	-6	28	-21	10
		5	12	14	-5	-8	7
Distance	5 sec.	1	11	12	-10	-25	-16
		2	9	11	12	8	-32
		3	-1	-2	-4	-3	-21
		4	14	27	-25	-10	-18
		5	12	5	12	-19	-29
	20 sec.	1	14	-4	-5	-7	-25
		2	22	7	12	8	-24
		3	3	13	12	-3	-26
		4	22	-12	30	-13	-25
		5	12	37	15	-16	-24
	90 sec.	1	15	5	-11	-6	-23
		2	18	31	-11	20	-26
		3	10	17	21	9	-14
		4	8	-7	25	3	-34
		5	40	54	-24	-24	-45

3.31

APPENDIX 3.IX

AE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENTS 3.4

SIGHTED

LOCATION

Subject Sl.No.	PRESELECTED				CONSTRAINED			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.26	0.30	0.88	0.66	0.90	0.86	2.56	2.26
2	0.14	0.28	0.94	0.80	0.80	1.02	2.54	3.00
3	0.18	0.30	0.70	0.74	0.74	1.10	2.66	2.38
4	0.20	0.28	0.30	0.80	0.54	1.20	2.72	3.70
5	0.14	0.20	0.76	0.64	0.88	1.34	2.30	2.78
DISTANCE								
1	0.46	0.46	1.48	2.16	1.60	2.76	2.54	5.12
2	0.44	0.60	1.68	1.82	2.64	2.84	2.28	5.02
3	0.72	0.64	1.38	1.26	1.68	2.92	2.84	4.52
4	0.62	0.52	1.60	1.58	2.88	2.94	3.22	5.60
5	0.50	0.56	1.40	1.02	2.16	2.86	3.26	6.00

Contd.....

APPENDIX 3.IX

AS SCORES OF SUBJECTS ON HORIZONTAL

TASK IN EXPERIMENTS 3.4

SIGHTED

LOCATION

Subject No.	PRESENTED				CONTRALATERAL			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.26	0.30	0.88	0.66	0.90	0.86	2.56	2.26
2	0.14	0.28	0.94	0.80	0.80	1.02	2.54	3.00
3	0.18	0.30	0.70	0.74	0.74	1.10	2.66	2.38
4	0.20	0.28	0.30	0.80	0.74	1.20	2.72	3.70
5	0.14	0.20	0.76	0.64	0.58	1.34	2.20	2.76

DISTANCE

1	0.46	0.46	1.48	2.16	1.60	2.76	2.54	5.12
2	0.44	0.60	1.82	1.82	2.64	2.84	2.28	5.02
3	0.72	0.64	1.32	1.26	1.08	2.02	2.84	4.32
4	0.62	0.52	1.60	1.58	2.88	2.94	3.22	5.80
5	0.50	0.56	1.40	1.02	2.16	2.66	3.26	6.00

Contd.....

3.32

APPENDIX 3.IX (CONTD.)

BLIND.

LOCATION

Sl.No.	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.26	0.28	1.06	0.78	0.62	1.00	1.82	1.92
2	0.24	0.56	1.08	1.54	0.88	1.90	2.44	2.22
3	0.46	0.34	0.90	1.40	0.92	1.52	2.10	2.08
4	0.52	0.50	1.66	0.84	0.78	1.60	1.78	2.04
5	0.26	0.56	0.86	1.00	0.98	0.90	1.78	2.22

DISTANCE

1	1.82	2.44	3.90	7.48	2.08	2.28	4.48	9.44
2	1.96	3.08	3.46	7.98	2.08	3.10	4.10	9.18
3	1.78	3.04	3.40	6.48	1.62	3.06	3.70	7.16
4	1.52	1.26	4.02	9.08	1.72	1.24	4.20	9.26
5	2.36	1.86	4.02	8.84	1.86	1.84	4.30	9.56

APPENDIX 3.IX (CONTD.)

BLIND.

LOCALITION

Sl.No.	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.26	0.28	1.06	0.78	0.62	1.00	1.32	1.32
2	0.24	0.56	1.08	1.54	0.88	1.90	2.44	2.22
3	0.46	0.34	0.90	1.40	0.92	1.92	2.10	2.08
4	0.52	0.50	1.66	0.84	0.78	1.60	1.78	2.04
5	0.26	0.56	0.86	1.00	0.98	0.90	1.78	2.22

DISTANCE

1	1.82	2.44	3.90	7.48	2.08	2.28	4.48	9.44
2	1.96	3.08	3.46	7.98	2.08	3.10	4.10	9.18
3	1.78	3.04	3.40	6.48	1.82	3.06	3.70	7.16
4	1.52	1.26	4.02	9.08	1.72	1.24	4.20	9.26
5	2.36	1.86	4.02	8.84	1.86	1.84	4.30	9.56

3.33

APPENDIX 3.X

VE SCORES OF SUBJECTS ON HORIZONTAL TASK

IN EXPERIMENT 3.4

SIGHTED

LOCATION

Subject Sl.No.	PRESELECTED				CONSTRAINED			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.28	0.25	0.87	0.80	0.66	0.48	0.80	2.39
2	0.23	0.34	1.00	0.75	0.54	0.91	1.79	2.36
3	0.23	0.29	0.48	0.80	0.28	1.21	2.13	2.00
4	0.27	0.32	0.22	0.73	0.38	0.89	1.35	0.92
5	0.20	0.14	0.65	0.67	0.34	0.69	1.47	2.22
DISTANCE								
1	0.49	0.47	0.52	1.07	1.75	0.46	1.45	1.67
2	0.47	0.75	0.87	1.96	1.36	2.58	0.35	1.91
3	0.69	0.31	0.98	1.20	1.75	2.66	0.89	1.18
4	0.63	0.65	1.14	1.32	2.51	1.87	2.54	1.98
5	0.62	0.53	1.15	0.97	2.27	2.23	2.49	2.91

Contd.....

APPENDIX 7.X

VE SCORES OF SUBJECTS ON NUMERICAL TASK

IN EXPERIMENT 3.4

LOCATION

Subject Sl.No.	PRESENTED				CONSTRUCTED			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.28	0.25	0.87	0.80	0.66	0.48	0.80	2.29
2	0.23	0.34	1.00	0.75	0.34	0.91	1.70	2.38
3	0.23	0.29	0.48	0.80	0.28	1.21	2.13	2.00
4	0.27	0.32	0.82	0.73	0.38	0.89	1.35	0.38
5	0.20	0.14	0.65	0.67	0.34	0.89	1.47	2.82

DISTANCE

1	0.49	0.47	0.32	1.07	1.75	0.48	1.45	1.89
2	0.47	0.75	0.87	1.96	1.36	2.18	0.35	1.91
3	0.69	0.31	0.98	1.20	1.75	2.66	0.89	1.18
4	0.63	0.65	1.14	1.32	2.31	1.87	2.51	1.38
5	0.62	0.53	1.15	0.97	2.27	2.23	2.49	2.91

Contd.....

APPENDIX 3.X (CONTD.)

BLIND

Sl.No.	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
LOCATION								
1	0.29	0.27	1.21	0.25	0.63	0.47	1.20	1.96
2	0.26	0.14	1.11	1.66	0.99	0.86	2.42	2.26
3	0.45	0.21	0.99	0.71	0.81	0.48	0.97	2.11
4	0.17	0.39	0.55	0.41	0.91	1.34	1.57	1.43
5	0.30	0.60	0.64	0.94	0.56	0.71	1.67	0.71
DISTANCE								
1	1.85	1.79	2.14	3.61	0.70	2.40	0.41	3.88
2	1.87	2.54	0.95	3.06	1.43	3.39	1.53	4.10
3	1.84	3.10	3.25	3.16	1.49	3.29	2.56	3.03
4	1.61	1.47	4.63	9.18	1.56	1.09	1.42	3.70
5	2.30	1.96	4.85	3.15	1.60	1.93	1.68	4.34

3.35

APPENDIX 3.XI

CE SCORES OF SUBJECTS ON HORIZONTAL TASK

IN EXPERIMENT 3.4

SIGHTED

LOCATION

Subject Sl.No.	PRESELECTED				CONSTRAINED			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.06	0.30	-0.64	0.10	0.70	0.86	-2.56	-0.18
2	0.06	0.04	-0.22	-0.36	0.64	0.54	-1.94	1.88
3	0.06	-0.18	0.70	-0.18	0.74	-0.38	1.62	1.38
4	-0.04	0.08	0.30	-0.56	0.54	1.00	2.72	-3.70
5	0.06	0.20	-0.44	-0.04	0.88	1.34	1.90	1.78

DISTANCE

1	-0.14	-0.18	-1.48	-2.16	0.12	2.76	-2.54	-5.12
2	-0.20	0.28	-1.68	-0.22	+2.64	-1.04	-2.28	-5.02
3	0.36	-0.64	-1.38	0.66	-0.44	-1.68	-2.84	-4.52
4	-0.06	-0.28	-1.28	-1.18	1.88	-2.58	-2.10	-5.60
5	-0.18	-0.28	-1.20	-0.94	-0.36	1.82	-2.26	-6.00

Contd....

APPENDIX 3.XI

CE SCORES OF SUBJECTS ON HORIZONTAL TASK

IN EXPERIMENT 3.A

DELETED

LOCATION

Subject Sl.No.	PRESENTED				CONSTRUCTED			
	Short targets		Long targets		Short targets		Long targets	
	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	0.06	0.30	-0.64	0.10	0.70	0.86	-4.30	-0.72
2	0.06	-0.04	-0.22	-0.36	0.04	0.34	-1.04	1.38
3	0.06	-0.18	0.70	-0.14	0.74	-0.38	1.68	1.38
4	-0.04	0.08	0.30	-0.36	-0.34	1.30	2.12	-3.70
5	0.06	0.20	-0.14	-0.04	0.88	-1.34	1.90	1.48

DISTANCE

1	-0.14	-0.18	-1.28	-2.16	0.16	8.78	-4.24	-5.46
2	-0.20	0.28	-1.68	-0.22	4.64	-1.04	-4.22	-5.42
3	0.36	-0.64	-1.38	0.66	-0.44	-1.66	-4.84	-5.32
4	-0.06	-0.28	-1.28	-1.78	1.28	-2.32	-4.10	-5.60
5	-0.18	-0.28	-1.20	-0.94	-0.36	1.82	-3.86	-4.00

Contd....

3.36 APPENDIX 3.XI (CONTD.)

BLINDS

LOCATION

Sl.No.	5.sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	-0.02	0.12	-0.42	-0.78	-0.18	1.00	1.50	-0.16
2	0.16	0.56	0.48	-0.34	0.28	1.90	0.76	0.94
3	0.18	0.34	0.06	-1.40	0.56	1.52	2.10	1.08
4	0.52	0.50	1.66	0.84	0.02	1.00	1.30	2.04
5	-0.06	-0.28	0.86	-0.52	0.98	0.66	0.78	2.22

DISTANCE

1	-0.06	1.96	-3.90	-7.48	2.08	0.08	-4.48	-9.44
2	-0.88	2.08	-3.46	-7.98	1.88	-0.54	-4.10	-9.18
3	-0.66	0.76	-2.52	-6.48	1.22	0.42	-3.10	-7.16
4	-0.44	0.06	-0.38	-3.76	0.92	-0.68	-4.20	-9.26
5	-0.60	-0.34	-0.90	-8.84	-1.26	0.12	-4.30	-9.56

PLUMBS

LOCALITY

Sl.No.	S.sec	90 sec	5 sec	90 sec	5 sec	90 sec	5 sec	90 sec
1	-0.06	0.12	-0.42	-0.78	-0.18	1.00	1.50	-0.16
2	0.16	0.56	0.48	-0.34	0.24	1.50	0.76	0.04
3	0.18	0.74	0.06	-1.40	0.58	0.52	2.10	1.08
4	0.52	0.50	1.66	0.84	0.06	1.00	1.30	2.04
5	-0.06	-0.28	0.86	-0.32	0.98	0.60	0.78	2.82

DISTANCE

1	-0.06	1.36	-3.90	-7.42	2.92	0.08	-1.48	-2.44
2	-0.88	2.08	-3.48	-7.98	1.88	-0.72	-1.10	-0.18
3	-0.66	0.76	-5.38	-6.42	1.22	0.42	-2.10	-1.76
4	-0.44	0.06	-0.38	-3.76	0.96	-0.68	-4.80	-0.36
5	-0.60	-0.34	-0.30	-8.84	-1.26	0.12	-4.30	-0.36

3.37

APPENDIX 3.XII

AE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.18	0.25	0.28	0.33	0.28	0.30	0.28
0	0	20	0.70	0.55	0.48	0.63	0.65	0.40	0.45
0	0	30	1.48	1.38	1.80	1.13	1.13	1.58	1.73
0	2	10	1.15	2.40	1.98	1.45	2.18	1.60	1.55
0	2	20	2.15	2.45	1.93	2.53	2.43	2.05	2.68
0	2	30	3.08	3.65	3.80	2.73	3.70	3.50	3.70
0	4	10	2.98	3.75	3.15	2.75	3.23	3.05	3.10
0	4	20	3.50	4.15	3.88	3.75	3.65	3.95	4.05
0	4	30	5.10	5.75	5.18	5.48	5.40	5.95	5.93
15	0	10	0.15	0.20	0.40	0.18	0.08	0.15	0.30
15	0	20	0.28	0.55	0.55	0.70	0.60	0.60	0.63
15	0	30	0.98	1.45	1.13	1.50	1.75	1.58	1.08
15	2	10	1.73	1.85	2.23	1.18	1.63	1.05	1.85
15	2	20	1.83	2.43	2.48	2.38	2.45	2.38	2.38
15	2	30	2.55	3.93	3.78	2.83	3.68	3.60	3.93
15	4	10	2.58	3.23	3.55	2.73	3.05	3.08	2.63
15	4	20	3.13	4.33	3.93	3.55	3.95	3.83	3.83
15	4	30	4.45	5.55	5.65	5.18	5.45	5.70	5.93
50	0	10	0.30	0.25	0.30	0.28	0.25	0.15	0.18
50	0	20	0.58	0.65	0.53	0.63	0.55	0.60	0.68
50	0	30	1.15	1.93	1.43	1.53	1.43	1.78	1.75
50	2	10	1.55	1.88	1.93	1.85	2.00	1.80	1.90
50	2	20	2.48	2.38	2.53	2.23	2.45	2.33	2.10
50	2	30	3.30	3.85	4.25	2.95	3.93	3.93	3.58
50	4	10	2.83	3.48	3.23	2.70	3.35	2.80	3.23
50	4	20	3.25	3.88	3.98	3.38	4.03	4.05	4.00
50	4	30	4.95	5.38	5.33	4.68	5.63	5.38	6.20

Contd...

APPENDIX 3.XII

AS SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.3

SIGNED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.78	0.25	0.29	0.33	0.22	0.30	0.22
0	0	20	0.70	0.55	0.26	0.63	0.65	0.20	0.43
0	0	30	1.28	1.38	1.80	1.13	1.13	1.38	1.73
0	2	10	1.15	2.20	1.38	1.43	2.18	1.60	1.55
0	2	20	2.15	2.45	1.93	2.33	2.43	2.03	2.08
0	2	30	3.08	3.65	3.30	2.73	3.70	3.30	3.70
0	4	10	2.98	3.75	3.15	2.75	3.25	3.08	3.10
0	4	20	3.50	4.15	3.88	3.75	3.65	3.95	4.08
0	4	30	5.10	5.75	5.16	5.48	5.40	5.98	5.93
15	0	10	0.15	0.20	0.20	0.18	0.08	0.15	0.30
15	0	20	0.28	0.55	0.55	0.70	0.80	0.60	0.83
15	0	30	0.98	1.45	1.13	1.30	1.75	1.58	1.08
15	2	10	1.75	1.85	2.25	1.18	1.63	1.05	1.83
15	2	20	1.83	2.43	2.48	2.38	2.45	2.38	2.38
15	2	30	2.55	3.93	2.78	2.83	3.08	3.00	3.03
15	4	10	2.58	3.23	3.55	2.73	3.05	3.08	2.83
15	4	20	3.13	4.35	3.98	3.55	3.95	3.83	3.68
15	4	30	4.45	5.55	5.65	5.18	5.43	5.78	5.23
50	0	10	0.30	0.25	0.30	0.28	0.25	0.13	0.18
50	0	20	0.58	0.05	0.59	0.63	0.35	0.00	0.68
50	0	30	1.15	1.23	1.23	1.53	1.43	1.38	1.28
50	2	10	1.55	1.88	1.93	1.88	2.00	1.83	1.90
50	2	20	2.48	2.38	2.53	2.43	2.45	2.33	2.18
50	2	30	3.30	3.63	4.23	2.98	3.98	3.03	3.38
50	4	10	2.83	3.43	3.23	2.70	3.35	3.80	3.23
50	4	20	3.25	3.88	3.98	3.38	4.03	4.03	4.00
50	4	30	4.95	5.38	5.33	4.68	5.63	5.38	5.20

Contd...

3.38

APPENDIX 3.XII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.78	1.23	1.38	1.05	1.38	1.25	1.20
0	0	20	2.38	1.85	1.90	1.73	2.35	1.68	1.83
0	0	30	3.20	2.70	2.68	2.65	2.68	3.38	2.75
0	2	10	1.60	1.53	1.03	0.98	1.90	1.93	1.65
0	2	20	2.28	2.18	2.00	2.05	2.30	1.98	1.95
0	2	30	2.43	2.93	3.28	3.00	3.55	3.00	3.05
0	4	10	1.95	1.68	1.43	1.35	1.93	1.85	1.23
0	4	20	2.15	2.38	1.68	2.00	2.28	2.15	1.98
0	4	30	2.70	3.10	3.15	2.90	3.45	3.90	2.73
15	0	10	3.10	3.18	2.38	3.58	2.50	2.73	2.98
15	0	20	3.93	4.05	3.05	3.55	4.13	4.25	3.78
15	0	30	6.45	5.85	5.73	6.75	5.53	6.35	5.33
15	2	10	3.10	3.58	3.10	3.18	3.45	2.85	3.23
15	2	20	3.65	3.38	3.08	3.25	4.18	4.30	3.45
15	2	30	5.10	4.60	5.58	5.30	5.70	5.80	5.95
15	4	10	3.25	3.40	2.95	2.98	3.15	2.95	3.03
15	4	20	3.50	4.00	3.35	3.25	3.63	3.85	3.60
15	4	30	5.73	5.45	5.43	5.43	6.35	5.40	5.83
50	0	10	3.93	5.55	4.68	4.50	5.38	4.48	4.75
50	0	20	5.05	5.88	4.93	4.30	6.13	5.75	5.73
50	0	30	7.83	8.38	7.48	8.08	8.20	8.10	8.10
50	2	10	4.78	4.83	4.63	4.43	5.18	4.33	4.68
50	2	20	5.23	5.10	4.75	4.90	5.90	5.90	5.13
50	2	30	7.23	8.33	7.43	7.98	7.88	8.75	8.13
50	4	10	5.05	4.95	4.68	4.70	4.70	4.78	4.35
50	4	20	6.03	5.68	4.68	4.38	5.65	5.88	5.23
50	4	30	7.30	8.30	7.23	8.00	8.13	7.83	7.65

Contd.....

APPENDIX 3.XII (CONTD.)

DISTANCE	CONDITIONS		SUBJECTS							
RI (deg)	P.d.	T (cm)	1	2	3	4	5	6	7	
0	0	10	1.78	1.23	1.38	1.05	1.38	1.85	1.20	
0	0	20	2.38	1.85	1.90	1.27	2.35	1.68	1.85	
0	0	30	3.20	2.70	2.68	2.65	2.68	3.38	2.73	
0	2	10	1.60	1.23	1.03	0.98	1.90	1.03	1.65	
0	2	20	2.28	2.18	2.00	2.05	2.30	1.98	1.95	
0	2	30	2.43	2.03	3.28	3.00	3.55	3.00	3.05	
0	4	10	1.35	1.68	1.43	1.35	1.93	1.85	1.23	
0	4	20	2.15	2.38	1.68	2.00	2.88	2.15	1.98	
0	4	30	2.70	3.10	3.15	2.30	3.43	3.20	2.73	
15	0	10	3.10	3.18	2.38	3.38	2.30	2.73	2.68	
15	0	20	3.93	4.05	3.65	3.55	4.15	4.23	3.78	
15	0	30	6.45	5.85	5.73	6.75	5.53	6.25	5.23	
15	2	10	3.10	3.38	3.10	3.18	3.43	2.83	3.23	
15	2	20	3.65	3.38	3.08	3.25	4.18	4.20	3.43	
15	2	30	5.10	4.60	5.38	5.30	5.70	5.20	5.58	
15	4	10	3.25	3.20	2.93	2.98	3.15	2.98	3.20	
15	4	20	3.50	4.00	3.35	3.25	3.63	3.83	3.48	
15	4	30	5.73	5.65	5.43	5.43	6.35	5.40	5.00	
50	0	10	3.93	5.53	4.68	4.50	5.38	4.48	4.38	
50	0	20	5.05	5.88	4.93	4.30	6.13	5.13	5.13	
50	0	30	7.83	8.38	7.48	8.08	8.20	8.10	8.10	
50	2	10	4.78	4.83	4.03	4.43	5.18	4.33	4.48	
50	2	20	5.23	5.10	4.75	4.90	5.90	5.00	5.13	
50	2	30	7.25	8.23	7.43	7.98	7.98	8.13	8.13	
50	4	10	5.05	4.95	4.68	4.70	4.70	4.73	4.33	
50	4	20	6.03	5.68	4.80	4.38	5.63	5.88	5.83	
50	4	30	7.30	8.30	7.23	8.00	8.13	7.83	7.48	

Contd.....

3.39

APPENDIX 3.XII (CONTD.)

BLIND

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	2.23	1.68	1.58	1.70	1.10	1.08	1.25
0	0	20	1.83	1.43	0.38	1.03	1.23	1.28	1.38
0	0	30	1.10	1.43	1.05	1.48	1.05	1.33	0.90
0	2	10	2.65	3.75	2.68	3.93	3.25	1.90	2.70
0	2	20	3.45	3.30	2.35	1.98	3.35	1.63	2.88
0	2	30	2.60	1.10	1.20	1.18	3.03	1.05	1.75
0	4	10	3.95	2.88	3.60	5.35	4.55	3.43	4.08
0	4	20	5.55	3.50	3.00	4.18	3.03	2.68	4.08
0	4	30	2.20	1.30	1.73	1.63	2.63	1.23	1.60
15	0	10	2.03	1.50	0.95	1.90	1.85	1.25	1.30
15	0	20	1.48	1.70	1.68	1.13	1.30	1.48	0.53
15	0	30	0.98	1.35	0.78	1.60	1.33	0.58	0.58
15	2	10	4.18	2.03	2.40	4.15	4.60	2.78	2.80
15	2	20	2.18	3.00	2.55	2.15	2.75	2.83	2.95
15	2	30	1.50	2.00	1.75	2.35	2.53	1.75	1.63
15	4	10	4.90	3.40	3.63	5.88	5.80	5.15	3.83
15	4	20	3.05	3.95	5.18	4.80	4.40	2.38	2.68
15	4	30	1.78	2.20	2.15	2.78	2.43	1.25	2.30
50	0	10	2.60	2.50	2.05	1.85	2.38	2.58	1.40
50	0	20	2.00	2.53	1.43	0.65	1.48	1.45	1.33
50	0	30	1.75	1.65	1.00	1.05	1.78	0.98	0.73
50	2	10	4.05	4.48	3.60	6.45	6.25	6.28	4.43
50	2	20	3.65	2.78	2.13	2.55	3.58	2.80	2.95
50	2	30	1.38	1.53	3.00	1.93	3.05	2.05	2.10
50	4	10	4.28	3.90	3.63	6.50	5.43	4.73	3.78
50	4	20	4.53	3.68	4.20	5.73	5.55	3.88	3.05
50	4	30	1.20	2.08	2.10	2.20	3.73	1.95	2.10

Contd...

APPENDIX 3.XII (CONTD.)

BLIND

LOCALITION

RI (sec)	P.M.	I (cm)	CONDITIONS 1	2	SUBJECTS 3	4	5	6	7
0	0	10	2.23	1.68	1.36	1.70	1.30	1.02	1.25
0	0	20	1.89	1.43	0.32	1.09	1.23	1.22	1.38
0	0	30	1.10	1.43	1.05	1.48	1.05	1.33	0.90
0	2	10	2.65	3.25	2.69	3.93	3.25	1.90	2.70
0	2	20	3.45	3.30	2.35	1.36	3.35	1.89	2.88
0	2	30	2.60	1.10	1.20	1.16	3.05	1.05	1.75
0	4	10	3.95	2.86	3.60	5.35	4.55	3.43	4.08
0	4	20	5.55	3.50	3.00	4.16	3.03	2.68	4.08
0	4	30	2.20	1.30	1.73	1.93	2.69	1.23	1.69
15	0	10	2.03	1.50	0.95	1.30	1.85	1.25	1.30
15	0	20	1.48	1.20	1.68	1.13	1.30	1.48	0.53
15	0	30	0.98	1.35	0.78	1.60	1.33	0.58	0.38
15	2	10	4.18	2.03	2.40	4.15	4.60	2.78	2.80
15	2	20	2.18	3.00	2.35	2.15	2.75	2.83	2.90
15	2	30	1.50	2.00	1.75	2.35	2.53	1.75	1.69
15	4	10	4.90	3.40	3.03	5.88	5.60	5.15	3.83
15	4	20	3.05	3.93	3.10	4.80	4.40	2.38	2.68
15	4	30	1.78	2.20	2.15	2.70	2.43	1.83	2.30
50	0	10	2.60	2.50	2.05	1.85	2.38	2.38	1.40
50	0	20	2.00	2.53	1.43	0.65	1.68	1.45	1.33
50	0	30	1.75	1.65	1.08	1.05	1.70	0.98	0.78
50	2	10	4.05	4.48	3.60	6.43	6.25	6.38	4.63
50	2	20	3.65	3.78	2.15	2.85	3.38	2.80	2.93
50	2	30	1.38	1.53	2.00	1.93	3.05	2.05	2.10
50	4	10	4.28	3.90	3.68	8.50	7.43	4.73	3.78
50	4	20	4.53	3.68	4.20	3.73	5.55	3.88	3.08
50	4	30	1.20	2.08	2.10	2.20	3.23	1.93	2.10

Contd...

3.40

APPENDIX 3.XII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.63	3.60	4.00	2.78	2.45	2.58	1.80
0	0	20	0.68	1.43	2.30	2.30	2.83	1.33	1.75
0	0	30	5.90	3.73	4.58	9.53	4.68	5.03	3.55
0	2	10	3.90	2.35	3.30	2.63	2.10	3.63	2.78
0	2	20	3.70	4.08	1.90	2.65	3.18	3.03	2.18
0	2	30	7.30	5.35	5.30	9.90	6.35	4.90	3.90
0	4	10	3.43	1.90	2.08	2.35	2.78	2.08	2.00
0	4	20	4.60	2.65	1.93	3.65	2.43	2.95	1.98
0	4	30	9.70	6.03	6.23	11.28	7.23	7.60	3.90
15	0	10	3.20	3.60	2.45	3.35	4.53	1.00	3.05
15	0	20	1.95	1.88	1.53	5.38	3.53	0.43	3.30
15	0	30	10.03	6.28	7.40	8.48	6.65	8.43	6.65
15	2	10	3.63	2.83	4.30	2.90	3.38	2.90	3.25
15	2	20	4.18	4.15	3.28	5.40	3.88	3.20	3.28
15	2	30	10.13	10.60	5.75	6.65	8.40	5.78	5.59
15	4	10	3.13	2.23	1.83	6.40	3.78	2.30	3.75
15	4	20	3.63	3.15	1.55	3.50	1.55	1.98	3.40
15	4	30	8.30	10.83	8.45	11.00	8.50	4.85	4.90
50	0	10	4.53	3.68	3.48	3.08	5.78	3.13	3.93
50	0	20	3.05	2.53	1.23	3.00	4.40	3.75	4.20
50	0	30	8.83	5.65	6.28	8.80	6.83	8.43	7.48
50	2	10	6.03	2.98	3.30	3.68	7.00	4.33	5.85
50	2	20	3.23	4.85	4.05	5.20	5.93	3.50	3.60
50	2	30	9.98	10.98	10.78	9.85	11.60	8.53	8.23
50	4	10	4.90	3.08	2.98	4.30	6.38	1.68	4.13
50	4	20	3.65	2.85	2.30	4.68	4.53	3.38	4.35
50	4	30	11.90	10.08	5.48	11.65	9.80	7.48	8.40

3.41

APPENDIX 3.XIII

VE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENTS 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.20	0.27	0.31	0.36	0.23	0.34	0.33
0	0	20	0.67	0.39	0.36	0.54	0.58	0.42	0.50
0	0	30	1.51	0.23	0.45	1.17	1.16	1.44	0.56
0	2	10	1.06	0.19	0.43	1.23	1.73	1.52	0.40
0	2	20	2.16	2.02	1.79	0.36	2.43	1.82	0.16
0	2	30	3.08	3.66	3.28	0.56	3.73	3.03	0.22
0	4	10	0.33	0.70	0.27	0.30	0.18	0.17	0.33
0	4	20	0.43	3.53	3.40	3.77	3.66	3.45	3.53
0	4	30	0.59	4.97	0.33	0.86	5.40	0.61	0.08
15	0	10	0.17	0.27	0.26	0.18	0.08	0.22	0.12
15	0	20	0.33	0.30	0.67	0.71	0.62	0.58	0.58
15	0	30	0.87	0.56	0.97	0.68	0.29	1.55	0.88
15	2	10	0.58	1.80	0.65	0.27	0.23	0.46	0.40
15	2	20	1.83	2.04	0.30	0.30	0.39	2.20	2.10
15	2	30	2.05	0.26	3.18	0.72	3.68	3.61	0.42
15	4	10	0.20	2.84	0.54	0.40	0.17	2.70	0.24
15	4	20	0.45	4.04	3.45	3.55	3.38	3.43	3.83
15	4	30	0.33	5.59	0.30	0.55	5.47	0.50	0.62
50	0	10	0.32	0.27	0.32	0.24	0.29	0.17	0.19
50	0	20	0.69	0.61	0.58	0.80	0.61	0.70	0.57
50	0	30	0.17	0.26	1.18	0.22	1.49	0.25	0.38
50	2	10	0.34	0.60	0.36	0.41	0.27	1.43	0.46
50	2	20	0.18	0.11	2.55	1.88	2.47	2.21	1.80
50	2	30	0.78	3.35	4.30	2.77	0.26	0.46	0.27
50	4	10	0.46	0.23	0.48	2.43	0.69	0.25	0.25
50	4	20	2.54	0.42	3.98	0.29	4.03	0.42	0.24
50	4	30	0.09	0.41	0.34	4.27	0.57	0.40	0.86

Contd....

3.42

APPENDIX 3.XIII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.a.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.78	0.28	1.14	1.05	0.18	1.28	0.48
0	0	20	2.07	1.86	1.53	1.46	1.94	1.34	1.53
0	0	30	0.41	2.14	2.57	0.21	0.28	0.33	2.46
0	2	10	1.16	1.54	0.15	0.98	0.35	1.55	1.25
0	2	20	0.15	1.79	2.01	1.79	2.31	1.96	0.32
0	2	30	0.56	0.49	0.29	0.29	2.77	2.61	2.89
0	4	10	0.29	1.39	0.38	0.35	0.22	0.32	1.06
0	4	20	1.82	2.15	1.42	1.73	2.04	1.95	1.56
0	4	30	2.30	0.34	0.52	2.55	2.83	0.27	2.38
15	0	10	0.44	0.33	0.29	2.94	2.13	2.26	0.39
15	0	20	3.93	3.44	0.18	3.28	3.69	3.74	0.46
15	0	30	1.58	0.50	0.65	1.32	4.62	0.50	4.29
15	2	10	2.61	0.38	3.25	0.65	0.43	2.86	0.98
15	2	20	3.13	0.60	3.16	2.65	0.59	3.60	2.77
15	2	30	4.61	3.83	0.70	1.04	5.71	0.26	5.03
15	4	10	0.43	2.91	2.50	2.98	2.58	2.65	0.46
15	4	20	3.51	3.42	2.75	2.76	3.63	3.85	3.62
15	4	30	5.78	0.61	0.86	5.04	5.72	0.32	0.48
50	0	10	3.46	5.57	3.86	3.76	4.98	0.18	0.78
50	0	20	4.58	5.12	0.37	0.29	6.13	5.00	5.73
50	0	30	1.09	0.44	0.63	0.87	0.62	0.51	0.92
50	2	10	3.96	0.39	0.64	0.55	1.04	0.78	0.13
50	2	20	5.26	0.94	4.09	4.94	0.44	5.95	5.19
50	2	30	1.11	0.44	0.38	0.36	1.02	1.15	0.47
50	4	10	0.82	0.22	0.34	0.59	0.67	0.88	3.73
50	4	20	5.12	1.00	0.84	3.83	5.18	1.19	4.78
50	4	30	1.29	0.54	0.33	0.64	1.00	0.66	0.21

Contd....

DISTANCE	CONDITIONS			SUBJECTS					
RL (cm)	r_{max}	T (cm)	1	2	3	4	5	6	7
0	0	10	1.78	0.22	1.14	1.05	0.13	1.29	0.42
0	0	20	2.07	1.36	1.22	1.46	1.84	1.34	1.35
0	0	30	0.41	2.14	2.27	0.21	0.24	0.33	2.46
0	2	10	1.16	1.34	0.45	0.48	0.15	1.55	1.24
0	2	20	0.15	1.79	2.01	1.79	2.11	1.06	0.32
0	2	30	0.56	0.49	0.29	0.29	2.77	2.41	2.39
0	4	10	0.29	1.39	0.36	0.35	0.23	0.35	1.46
0	4	20	1.82	2.15	1.42	1.73	2.14	1.75	1.84
0	4	30	2.30	0.34	0.52	2.55	2.23	0.27	2.15
15	0	10	0.44	0.33	0.29	2.44	2.13	2.20	0.39
15	0	20	3.32	3.44	0.14	3.24	3.09	3.14	0.44
15	0	30	1.53	0.50	0.65	1.34	0.82	0.30	1.49
15	2	10	2.61	0.38	3.25	0.65	0.43	2.36	0.38
15	2	20	3.13	0.60	3.18	3.03	0.39	3.00	2.97
15	2	30	4.61	3.83	0.70	1.44	3.11	0.26	0.35
15	4	10	0.43	2.41	2.50	2.02	2.30	2.65	0.20
15	4	20	3.51	3.42	3.13	2.36	3.03	3.45	3.02
15	4	30	5.76	0.61	0.26	5.44	5.12	0.38	0.27
30	0	10	3.46	3.27	3.30	3.06	4.38	0.13	0.30
30	0	20	4.34	3.12	0.37	0.39	3.13	3.09	3.13
30	0	30	1.09	0.44	0.65	0.27	0.28	0.31	0.38
30	2	10	3.36	0.39	0.44	0.33	1.44	0.38	0.13
30	2	20	3.20	0.34	0.04	3.04	0.44	3.05	3.13
30	2	30	1.11	0.44	0.36	0.36	1.12	1.13	0.27
30	4	10	0.22	0.13	0.29	0.27	0.27	0.21	0.23
30	4	20	3.12	1.00	0.24	3.23	3.18	1.19	0.23
30	4	30	1.29	0.32	0.39	0.34	1.07	0.26	0.27

Contd....

3.43

APPENDIX 3.XIII (CONTD.)

BLINDS

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.29	0.57	0.84	0.81	0.22	0.72	0.35
0	0	20	0.86	0.99	0.26	1.15	1.33	0.94	0.87
0	0	30	0.50	1.48	0.87	0.62	0.69	1.43	1.03
0	2	10	0.67	0.98	0.39	1.54	0.69	0.35	0.07
0	2	20	0.97	0.74	1.96	0.40	1.02	0.44	0.59
0	2	30	0.67	1.12	0.32	0.94	3.17	0.98	1.98
0	4	10	1.23	0.33	0.89	0.76	1.17	0.58	1.04
0	4	20	0.80	1.26	0.80	0.75	0.51	0.40	0.37
0	4	30	0.57	1.39	0.47	1.08	2.56	1.26	1.23
15	0	10	0.59	0.52	1.01	1.24	0.21	0.55	0.31
15	0	20	0.89	1.73	0.74	1.14	1.40	0.70	0.64
15	0	30	1.01	1.26	0.96	0.85	1.20	0.51	0.66
15	2	10	0.50	1.54	0.74	1.43	0.60	0.52	0.51
15	2	20	0.83	0.74	2.61	0.52	2.37	0.76	2.86
15	2	30	1.79	2.19	1.94	0.82	0.13	0.56	0.69
15	4	10	0.94	0.71	1.08	0.98	1.61	0.99	0.92
15	4	20	0.87	3.18	4.96	1.22	0.89	0.69	0.70
15	4	30	1.63	2.56	0.69	2.19	2.42	1.13	0.91
50	0	10	1.68	0.83	1.13	0.53	0.38	0.58	0.58
50	0	20	0.87	0.19	0.30	0.61	0.56	0.30	0.95
50	0	30	1.88	1.69	1.08	1.13	0.45	1.10	0.90
50	2	10	0.97	0.55	0.54	1.78	1.22	0.64	1.26
50	2	20	0.67	2.33	0.97	1.01	3.70	0.37	2.96
50	2	30	1.55	0.87	2.92	1.12	2.61	1.05	0.66
50	4	10	0.70	3.59	0.46	3.49	1.27	0.97	0.69
50	4	20	3.65	2.75	4.24	4.99	4.57	1.06	2.88
50	4	30	1.21	1.91	2.21	2.24	2.22	2.14	1.42

Contd...

APPENDIX 3.XIII (CONTD.)

BLEIBUS

LOCALITY	CONDITIONS			SOLDIERS						
	RI (sec)	P.A.	T (mm)	1	2	3	4	5	6	7
	0	0	10	0.29	0.27	0.34	0.87	0.22	0.72	0.25
	0	0	20	0.86	0.39	0.26	1.15	1.32	0.94	0.87
	0	0	30	0.50	1.49	0.87	0.68	0.89	1.42	1.03
	0	2	10	0.67	0.98	0.39	1.54	0.69	0.39	0.47
	0	2	20	0.97	0.74	1.36	0.40	1.02	0.44	0.59
	0	2	30	0.87	1.12	0.32	0.94	2.17	0.92	1.90
	0	4	10	1.23	0.23	0.39	0.76	1.17	0.52	1.04
	0	4	20	0.30	1.26	0.90	0.15	0.51	0.40	0.37
	0	4	30	0.52	1.39	0.47	1.06	2.56	1.26	1.23
	15	0	10	0.59	0.52	1.01	1.24	0.21	0.55	0.31
	15	0	20	0.89	1.73	0.74	1.14	1.10	0.70	0.84
	15	0	30	1.01	1.26	0.96	0.85	1.20	0.31	0.66
	15	2	10	0.50	1.52	0.74	1.13	0.60	0.2	0.31
	15	2	20	0.89	0.74	2.61	0.32	2.37	0.76	2.84
	15	2	30	1.79	2.19	1.94	0.28	0.19	0.36	0.89
	15	4	10	0.84	0.71	1.08	0.48	1.01	0.39	0.36
	15	4	20	0.87	3.18	4.96	1.72	0.89	0.89	0.79
	15	4	30	1.63	2.56	0.69	2.19	2.22	1.13	0.91
	50	0	10	1.68	0.83	1.13	0.52	0.36	0.38	0.68
	50	0	20	0.87	0.19	0.30	0.61	0.30	0.20	0.25
	50	0	30	1.58	1.69	1.08	1.13	0.45	1.10	0.90
	50	2	10	0.27	0.55	0.34	1.78	1.22	0.64	1.26
	50	2	20	0.27	2.33	0.27	1.21	3.20	0.77	2.58
	50	2	30	1.55	0.27	2.02	1.12	2.61	1.05	0.66
	50	4	10	0.70	3.59	0.46	3.49	1.29	0.27	0.63
	50	4	20	3.65	2.75	4.24	1.95	4.37	1.06	2.88
	50	4	30	1.21	1.91	2.27	2.24	2.02	1.14	1.32

Contd...

3.44

APPENDIX 3.XIII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.44	0.50	1.03	0.51	1.20	0.88	0.83
0	0	20	0.75	1.43	2.44	1.01	3.57	1.07	1.77
0	0	30	1.23	1.13	2.45	1.53	0.94	1.80	0.86
0	2	10	2.93	2.55	2.67	0.68	1.48	2.27	0.60
0	2	20	2.61	1.11	2.14	0.70	0.61	3.56	1.96
0	2	30	1.99	2.47	1.27	0.87	2.44	1.87	1.18
0	4	10	1.85	0.75	1.56	0.29	1.12	1.64	1.36
0	4	20	3.07	1.54	2.58	0.46	1.53	3.20	2.05
0	4	30	2.07	2.19	2.11	2.16	2.93	1.48	1.29
15	0	10	1.35	1.37	0.92	1.14	1.70	1.18	2.78
15	0	20	1.96	1.97	1.33	5.14	3.58	0.41	2.40
15	0	30	1.19	4.11	1.45	1.84	0.99	1.16	1.80
15	2	10	0.51	2.91	4.78	1.34	1.67	1.60	0.43
15	2	20	1.43	1.42	0.71	1.26	0.99	2.95	2.99
15	2	30	0.63	1.44	1.37	5.23	1.20	4.00	1.40
15	4	10	1.21	2.18	1.83	0.51	1.56	1.88	3.38
15	4	20	3.80	0.86	1.72	0.64	1.80	2.02	3.47
15	4	30	1.78	1.01	2.32	2.31	1.66	1.76	3.02
50	0	10	0.50	2.04	0.55	2.06	1.80	2.46	1.19
50	0	20	2.57	1.08	0.51	0.60	1.10	3.36	4.38
50	0	30	1.31	1.94	0.90	1.51	4.39	2.00	3.59
50	2	10	1.30	3.00	1.39	0.65	1.46	2.25	1.90
50	2	20	2.74	0.43	0.44	0.79	0.56	1.14	4.12
50	2	30	1.61	1.41	1.07	6.31	1.09	2.02	2.58
50	4	10	1.79	2.47	2.10	1.57	0.80	0.44	2.74
50	4	20	1.75	2.36	2.31	1.05	1.19	2.44	4.05
50	4	30	4.60	1.43	2.43	1.09	1.74	1.81	4.35

3.45

APPENDIX 3.XIV

CE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3 3	4	5	6	7
0	0	10	0.18	0.15	0.03	-0.08	0.18	0.05	-0.03
0	0	20	0.30	0.55	0.48	-0.43	0.30	0.10	-0.05
0	0	30	-0.13	-1.38	-1.80	-0.23	-0.13	-0.68	-1.73
0	2	10	0.50	2.40	1.98	0.85	1.38	0.65	1.55
0	2	20	-0.15	1.40	0.93	-2.53	0.13	-0.95	2.68
0	2	30	-0.03	0.10	2.00	-2.73	0.15	-1.80	-3.70
0	4	10	2.98	3.75	3.15	2.75	3.23	3.05	3.10
0	4	20	-3.50	2.20	-1.88	0.00	-0.10	-1.95	-2.05
0	4	30	-5.10	-2.90	-5.18	-5.48	0.15	-5.95	-5.93
15	0	10	-0.05	0.15	0.40	0.18	0.08	0.05	0.30
15	0	20	0.03	0.55	0.00	0.10	0.00	0.20	-0.28
15	0	30	0.73	-1.45	-0.73	-1.50	-1.75	-0.58	-0.68
15	2	10	1.73	0.60	2.33	1.18	1.63	1.25	1.85
15	2	20	-0.03	1.33	2.48	-2.38	2.45	-0.98	-1.18
15	2	30	-1.55	-3.93	-2.08	-2.83	0.03	-0.60	-3.93
15	4	10	2.58	1.78	3.55	2.73	3.05	1.48	2.63
15	4	20	3.13	1.73	1.88	0.10	-2.05	1.73	0.03
15	4	30	-4.45	0.05	-5.65	-5.18	-0.30	-5.70	-5.93
50	0	10	0.00	0.05	0.00	0.28	0.10	0.05	0.13
50	0	20	-0.23	0.25	0.23	0.08	-0.15	0.10	-0.48
50	0	30	-1.15	-1.93	-0.88	-1.53	-0.08	-1.78	-1.75
50	2	10	1.55	1.83	1.93	1.85	2.00	1.15	1.90
50	2	20	2.48	2.38	0.03	1.23	-0.35	-0.83	-1.10
50	2	30	-3.30	-1.90	-0.45	-1.10	-3.93	-3.93	-3.58
50	4	10	2.83	3.48	3.23	1.20	3.35	2.80	3.23
50	4	20	-1.95	-3.88	0.08	-3.38	0.43	-4.05	-4.00
50	4	30	-4.95	-5.38	-5.33	-2.23	-5.63	-5.38	-6.20

Contd....

APPENDIX 3.XIV

CE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.5

SIGHTED

CONDITIONS			LOCATION	SUBJECTS						
RL (sec)	P-A.	T (cm)		1	2	3	4	5	6	7
0	0	10		0.18	0.15	0.03	-0.08	0.18	0.05	-0.03
0	0	20		0.30	0.35	0.48	-0.43	0.30	0.10	-0.05
0	0	30		-0.13	-1.38	-1.80	-0.23	-0.13	-0.88	-1.23
0	2	10		0.50	2.40	1.98	0.85	1.38	0.65	1.85
0	2	20		-0.15	1.40	0.93	-2.33	0.15	-0.95	-0.98
0	2	30		-0.03	0.10	2.00	-2.73	0.15	-1.80	-3.70
0	4	10		2.98	3.75	3.15	2.25	3.23	3.05	3.10
0	4	20		-3.50	2.20	-1.88	0.00	-0.10	-1.95	-2.68
0	4	30		-5.10	-2.90	-5.18	-5.48	0.15	-5.95	-5.93
15	0	10		-0.05	0.15	0.40	0.18	0.08	0.05	0.30
15	0	20		0.03	0.55	0.00	0.10	0.00	0.60	-0.38
15	0	30		0.73	-1.45	-0.73	-1.50	-1.75	-0.38	-0.68
15	2	10		1.73	0.60	2.33	1.18	1.63	1.25	1.85
15	2	20		-0.03	1.33	2.48	-2.38	2.45	-0.98	-1.78
15	2	30		-1.55	-3.93	-2.08	-2.83	0.03	-0.60	-3.93
15	4	10		2.58	1.78	3.55	2.73	3.05	1.43	2.63
15	4	20		3.13	1.73	1.88	0.10	-2.05	1.73	0.08
15	4	30		-4.45	0.05	-5.65	-5.18	-0.30	-5.70	-5.93
50	0	10		0.00	0.05	0.00	0.28	0.10	0.05	0.13
50	0	20		-0.23	0.25	0.23	0.08	-0.15	0.10	-0.28
50	0	30		-1.15	-1.93	-0.88	-1.53	-0.05	-1.78	-1.75
50	2	10		1.55	1.88	1.93	1.85	2.00	1.13	1.90
50	2	20		2.48	2.38	0.03	1.23	-0.35	-0.83	-1.10
50	2	30		-3.30	-1.90	-0.45	-1.10	-3.93	-3.93	-3.38
50	4	10		2.83	3.48	3.23	1.90	3.35	2.80	3.13
50	4	20		-1.95	-3.88	0.08	-3.38	0.23	-4.05	-4.00
50	4	30		-4.95	-5.38	-5.33	-4.23	-5.63	-5.38	-6.80

Contd....

APPENDIX 3.XIV (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	8	9	10	11	12	13	14
0	0	10	0.13	1.23	0.78	0.25	1.38	-0.25	1.20
0	0	20	1.18	0.15	-1.15	-0.93	1.35	1.03	1.03
0	0	30	-3.20	-1.70	-0.93	-2.65	-2.68	-3.38	1.25
0	2	10	1.20	-0.33	1.03	0.33	1.90	1.18	1.15
0	2	20	2.28	-1.28	-0.10	-1.00	0.40	-0.58	1.95
0	2	30	-2.43	-2.93	-3.28	-3.00	-2.35	-1.65	-1.30
0	4	10	1.95	1.03	1.43	1.35	1.93	1.85	0.63
0	4	20	1.15	-1.03	0.93	-1.00	1.03	1.00	1.23
0	4	30	-1.45	-3.10	-3.15	-1.40	-2.20	-3.90	-1.33
15	0	10	3.10	3.18	2.38	2.08	1.35	1.63	2.98
15	0	20	0.28	2.15	-3.05	-1.45	1.88	-2.15	3.78
15	0	30	-6.45	-5.85	-5.73	-6.75	-3.08	-6.35	-3.23
15	2	10	1.75	3.58	0.70	3.18	3.45	0.45	3.23
15	2	20	1.95	-3.38	0.68	-1.95	4.18	-2.40	2.15
15	2	30	-2.30	-2.60	-5.58	-5.30	-0.95	-5.80	-3.20
15	4	10	3.25	1.80	1.65	0.03	1.90	1.35	3.03
15	4	20	-0.35	-2.10	-1.95	-1.75	-0.28	0.00	-0.10
15	4	30	-0.23	-5.45	-5.43	-2.13	-2.85	-5.40	-5.83
50	0	10	1.98	0.00	2.93	2.50	3.28	4.48	4.75
50	0	20	-2.20	-2.98	-4.93	-4.30	0.63	-2.85	-0.23
50	0	30	-7.83	-8.38	-7.48	-8.08	-8.20	-8.10	-8.10
50	2	10	2.78	4.83	4.63	4.43	5.18	4.33	4.68
50	2	20	0.08	5.10	-2.55	0.30	5.90	0.15	-0.23
50	2	30	-7.23	-8.33	-7.43	-7.98	-7.88	-8.75	-8.13
50	4	10	5.05	4.95	4.68	4.70	4.70	4.78	2.25
50	4	20	-3.28	-5.68	-4.68	-2.13	-2.50	-5.88	-2.18
50	4	30	-7.30	-8.30	-7.23	-8.00	-8.13	-7.83	-7.65

Contd.....

APPENDIX 3.XIV (CONTD.)

DISTANCE		CONDITIONS		SUBJECTS							
RI (mm)	F.A.	T (cm)	8	9	10	11	12	13	14
0	0	10	0.73	1.23	0.78	0.25	1.38	-0.25	1.20
0	0	20	1.18	0.15	-1.15	-0.95	1.35	1.05	1.42
0	0	30	-3.20	-1.70	-0.93	-2.65	-2.68	-3.38	1.82
0	2	10	1.20	-0.35	1.09	0.33	1.90	1.18	1.17
0	2	20	2.28	-1.28	-0.70	-1.00	0.40	-0.38	1.78
0	2	30	-2.43	-2.93	-3.28	-3.00	-6.35	-1.25	-1.30
0	4	10	1.95	1.05	1.43	1.35	1.93	1.85	0.68
0	4	20	1.15	-1.09	0.93	-1.00	1.03	1.00	1.23
0	4	30	-1.45	-3.10	-3.15	-1.40	-2.20	-3.90	-1.33
15	0	10	3.10	3.18	2.38	2.08	1.35	1.69	2.98
15	0	20	0.28	2.15	-3.05	-1.45	1.88	-2.15	3.78
15	0	30	-6.45	-5.85	-5.73	-6.75	-3.08	-6.35	-3.23
15	2	10	1.75	3.38	0.70	3.10	3.45	0.45	3.43
15	2	20	1.95	-3.38	0.68	-1.95	4.18	-2.40	1.43
15	2	30	-2.30	-2.60	-5.38	-5.30	-0.95	-5.80	-3.20
15	4	10	3.25	1.80	1.65	0.09	1.90	1.35	3.03
15	4	20	-0.35	-2.10	-1.95	-1.75	-0.28	0.00	-0.10
15	4	30	-0.23	-5.45	-3.43	-4.13	-2.69	-3.40	-3.83
30	0	10	1.98	0.00	4.20	2.80	3.28	4.08	4.20
30	0	20	-2.20	-2.98	-1.95	-4.30	0.09	-2.85	-0.73
30	0	30	-7.83	-8.38	-7.48	-5.08	-0.20	-4.10	-6.10
30	2	10	2.78	4.80	4.69	4.43	3.18	4.33	4.08
30	2	20	0.08	3.10	-2.35	0.30	3.90	0.73	-1.43
30	2	30	-7.29	-8.39	-7.43	-7.98	-2.73	-8.73	-8.18
30	4	10	3.05	4.93	4.08	4.70	4.70	4.78	3.83
30	4	20	-3.28	-3.08	-2.48	-2.13	-2.30	-3.68	-4.38
30	4	30	-7.30	-8.30	-7.23	-4.00	-8.13	-7.38	-7.65

3.47

APPENDIX 3.XIV (CONTD.)

BLINDS

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	2.23	1.68	1.58	1.70	1.10	1.08	1.25
0	0	20	1.83	1.18	0.38	0.43	0.48	1.28	1.28
0	0	30	1.10	-0.38	1.05	-1.48	-1.05	0.38	0.30
0	2	10	2.65	3.75	2.68	3.93	3.25	1.90	2.70
0	2	20	3.45	3.30	1.35	1.98	3.35	1.63	2.88
0	2	30	2.60	0.20	1.20	1.18	-0.73	0.45	0.25
0	4	10	3.95	2.88	3.60	5.35	4.55	3.43	4.08
0	4	20	5.55	3.50	3.00	4.18	3.03	2.68	4.08
0	4	30	2.20	-0.20	1.73	1.63	1.38	-0.43	-1.45
15	0	10	2.03	1.50	0.35	1.75	1.85	1.25	1.30
15	0	20	1.48	0.70	1.68	0.63	0.75	1.48	-0.08
15	0	30	0.48	-0.60	0.28	-1.60	-1.08	0.43	-0.33
15	2	10	4.18	1.43	2.40	4.15	4.60	2.78	2.80
15	2	20	2.18	3.00	0.55	2.15	1.50	2.83	1.15
15	2	30	0.10	0.65	-0.20	-2.35	-2.53	-1.75	-1.63
15	4	10	4.90	3.40	3.63	5.88	5.80	5.15	3.83
15	4	20	3.05	2.45	1.78	4.80	4.40	2.38	2.68
15	4	30	0.78	0.55	-2.15	1.88	-1.53	-0.65	-2.30
50	0	10	2.60	2.50	2.05	1.85	2.38	2.58	1.40
50	0	20	2.00	2.53	1.43	0.45	1.48	1.45	1.33
50	0	30	0.80	-0.85	-0.40	-0.05	-1.78	-0.33	-0.03
50	2	10	4.05	4.48	3.60	6.45	6.25	6.28	4.43
50	2	20	3.65	1.63	-2.13	2.55	1.08	2.80	-0.05
50	2	30	-0.13	-1.53	-1.00	-1.93	-1.85	-2.05	-2.10
50	4	10	4.28	1.65	3.63	6.50	5.43	4.73	3.78
50	4	20	3.28	2.63	-0.30	3.48	3.35	3.88	1.55
50	4	30	0.70	0.98	-0.35	1.00	-3.63	-0.45	-2.10

Contd....

DI (sec)	PA.	T (cm)	1	2	3	4	5	6	7
0	0	10	2.23	1.62	1.58	1.70	1.10	1.08	1.25
0	0	20	1.83	1.18	0.38	-0.43	0.24	1.24	1.24
0	0	30	1.10	-0.38	1.05	-1.28	-1.05	0.38	0.30
0	2	10	2.65	3.75	2.68	3.93	3.25	1.30	2.70
0	2	20	3.45	3.30	1.35	1.34	3.35	1.65	2.68
0	2	30	2.60	0.80	1.20	1.18	-0.73	0.45	0.25
0	4	10	3.95	2.88	3.00	5.33	4.93	3.43	4.08
0	4	20	5.55	3.50	3.00	4.18	3.23	2.88	2.08
0	4	30	2.20	-0.20	1.73	1.69	1.38	-0.43	-1.48
15	0	10	2.03	1.30	0.35	1.75	1.85	1.23	1.30
15	0	20	1.48	0.70	1.68	0.63	0.75	1.48	-0.08
15	0	30	0.28	-0.60	0.25	-1.00	-1.04	0.43	-0.33
15	2	10	4.18	3.43	2.40	4.15	4.00	2.78	2.80
15	2	20	2.18	3.00	0.64	0.15	1.30	2.38	1.15
15	2	30	0.10	0.65	-0.20	-0.38	-2.53	-1.78	-1.00
15	4	10	4.90	3.40	3.23	5.88	5.06	3.15	4.83
15	4	20	3.05	2.43	1.78	4.30	4.20	2.34	2.60
15	4	30	0.78	0.34	-2.15	1.88	-1.53	-0.83	-2.38
30	0	10	2.60	2.38	2.05	1.55	2.33	2.28	1.42
30	0	20	2.00	2.53	1.23	0.42	1.28	1.45	1.27
30	0	30	0.80	-0.88	-0.40	-0.05	-1.98	-0.33	-0.00
30	2	10	4.05	4.48	3.60	5.45	0.23	5.22	4.43
30	2	20	3.65	1.63	-2.13	2.55	1.08	2.80	-0.00
30	2	30	-0.13	-1.33	-4.08	-1.93	-1.85	-0.38	-2.70
30	4	10	4.28	1.88	3.63	4.10	3.43	4.13	3.38
30	4	20	3.28	2.63	-0.30	3.48	3.35	3.88	1.78
30	4	30	0.70	0.38	-0.35	1.00	-1.63	-0.48	-4.10

3.48

APPENDIX 3.XIV (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	8	9	10	11	12	13	14
0	0	10	1.43	3.60	4.00	2.78	2.45	2.58	1.80
0	0	20	0.13	-0.18	0.55	-2.30	0.23	-1.08	0.40
0	0	30	-5.90	-3.73	-4.58	-9.53	-4.68	-5.03	-3.55
0	2	10	3.30	0.25	2.55	2.63	2.00	3.63	2.78
0	2	20	-3.15	-4.08	0.20	-2.65	-3.18	-0.38	-1.03
0	2	30	-7.30	-5.35	-5.30	-9.90	-6.35	-4.90	-3.90
0	4	10	3.43	1.90	1.53	2.35	2.78	1.38	2.00
0	4	20	-4.10	-2.65	0.68	-3.65	-2.43	-0.15	0.73
0	4	30	-9.70	-6.03	-6.23	-11.28	-7.23	-7.60	-3.90
15	0	10	3.20	3.60	2.45	3.35	4.53	0.50	1.30
15	0	20	-0.45	-0.53	0.88	-4.38	1.13	-0.18	-2.55
15	0	30	-10.03	-5.78	-7.40	-8.48	-6.65	-8.43	-6.65
15	2	10	3.63	1.93	0.95	2.90	3.38	2.90	3.25
15	2	20	-4.18	-4.15	-3.28	-5.40	-3.88	-1.30	-1.53
15	2	30	-10.13	-10.60	-5.75	-5.00	-8.40	-5.53	-5.95
15	4	10	3.13	1.18	1.18	6.40	3.78	2.05	1.80
15	4	20	-0.53	-3.15	0.30	-3.50	-0.30	1.08	-0.15
15	4	30	-8.30	-10.83	-8.45	-11.00	-8.50	-4.85	-4.60
50	0	10	4.53	3.68	3.48	3.08	5.78	2.23	3.93
50	0	20	-1.65	-2.53	-1.23	-3.00	4.40	-1.85	-1.45
50	0	30	-8.83	-5.65	-6.28	-8.80	-6.08	-8.43	-7.48
50	2	10	6.03	2.23	3.30	3.68	7.00	4.33	5.85
50	2	20	-1.98	-4.85	-4.05	-5.20	-5.93	-3.50	0.30
50	2	30	-9.98	-10.98	-10.78	-8.90	-11.60	-8.53	-8.23
50	4	10	4.90	3.08	2.08	4.30	6.38	1.68	3.83
50	4	20	-3.65	-1.85	0.15	-4.68	-4.53	-3.38	1.70
50	4	30	-11.90	-10.08	-5.48	-11.65	-9.80	-7.48	-8.40

DISTANCE											
CONDITIONS											
RI (sec)	P.A.	I (cm)	8	9	10	11	12	13	14		
0	0	10	1.43	3.60	4.00	2.78	2.43	2.56	1.80		
0	0	20	0.13	-0.18	0.55	-2.30	0.23	-1.02	0.20		
0	0	30	-5.90	-3.73	-4.58	-9.53	-4.63	-5.09	-3.55		
0	2	10	3.30	0.25	2.55	1.63	2.00	3.63	2.38		
0	2	20	-3.15	-4.08	0.20	-8.65	-3.18	-0.38	-1.03		
0	2	30	-7.30	-5.35	-3.30	-13.90	-6.33	-4.30	-3.90		
0	4	10	3.43	1.90	1.33	2.35	2.38	1.38	2.00		
0	4	20	-4.10	-2.65	0.08	-3.65	-2.43	-0.13	0.73		
0	4	30	-9.70	-6.03	-6.23	-11.18	-7.23	-7.68	-3.90		
15	0	10	3.20	3.60	2.43	3.33	4.33	0.50	1.30		
15	0	20	-0.45	-0.33	0.88	-4.38	1.13	-0.18	-2.23		
15	0	30	-10.03	-5.78	-7.40	-8.48	-4.65	-8.43	-6.40		
15	2	10	3.69	1.93	0.95	2.90	3.38	0.90	2.48		
15	2	20	-4.18	-4.15	-3.28	-5.40	-3.78	-1.30	-1.38		
15	2	30	-10.13	-10.60	-5.75	-9.00	-8.40	-5.53	-5.93		
15	4	10	3.13	1.18	1.78	6.40	3.78	2.05	1.80		
15	4	20	-0.53	-3.15	0.30	-3.50	-0.30	1.08	-0.15		
15	4	30	-8.30	-10.83	-5.45	-11.00	-4.50	-4.85	-4.00		
30	0	10	4.53	3.68	3.48	5.08	3.78	2.53	3.40		
30	0	20	-1.65	-2.53	-1.23	-3.00	4.40	-1.88	-1.40		
30	0	30	-8.83	-5.65	-6.28	-8.30	-5.08	-8.43	-7.68		
30	2	10	6.03	4.23	3.30	3.68	7.03	4.20	3.88		
30	2	20	-1.98	-4.85	-4.03	-5.50	-2.83	-3.50	0.38		
30	2	30	-9.98	-10.38	-8.90	-11.00	-8.33	-8.23	-7.63		
30	4	10	4.90	3.08	5.00	4.30	6.34	1.88	3.80		
30	4	20	-3.65	-1.85	0.73	-4.08	-4.53	-3.38	-1.30		
30	4	30	-11.90	-10.03	-3.48	-11.68	-9.80	-7.48	-8.48		

3.49

APPENDIX 3.XV

AE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.45	1.13	1.33	1.45	1.83	1.60	1.70
0	0	20	1.98	1.83	1.88	1.83	2.13	1.68	2.60
0	0	30	3.03	3.58	2.53	3.30	3.35	2.43	3.55
0	2	10	1.63	1.53	1.10	1.95	2.05	1.43	2.05
0	2	20	2.10	1.88	2.08	1.55	2.33	2.15	2.40
0	2	30	2.85	3.75	2.70	2.85	3.40	2.28	3.50
0	4	10	1.73	1.60	1.20	1.93	1.68	1.55	1.75
0	4	20	2.10	2.25	1.80	2.00	2.03	1.85	2.20
0	4	30	3.43	3.65	2.93	3.25	3.28	2.55	3.25
15	0	10	2.58	2.38	2.28	2.98	2.85	3.18	3.00
15	0	20	3.83	3.20	2.78	3.65	3.65	3.10	3.73
15	0	30	5.90	7.08	4.25	5.60	5.08	5.23	5.75
15	2	10	2.73	2.68	2.13	2.78	2.93	2.78	2.90
15	2	20	3.68	3.40	2.60	3.73	3.55	3.15	3.63
15	2	30	5.78	6.40	3.65	5.65	5.48	4.55	5.43
15	4	10	2.83	2.78	2.43	3.18	2.98	3.40	2.80
15	4	20	3.55	3.10	2.83	3.50	3.58	2.55	4.13
15	4	30	5.45	6.75	4.75	4.78	4.95	4.45	5.55
50	0	10	4.73	4.28	3.85	4.50	4.38	3.93	4.70
50	0	20	5.40	5.95	4.70	5.88	5.00	5.73	6.25
50	0	30	7.95	9.18	7.28	7.45	9.20	8.25	8.23
50	2	10	4.58	4.33	4.35	4.38	4.05	4.50	4.53
50	2	20	5.53	5.33	5.35	5.60	4.65	5.83	5.20
50	2	30	7.85	9.33	7.08	8.05	9.53	8.33	8.70
50	4	10	4.38	4.00	4.25	4.90	4.73	4.25	4.80
50	4	20	5.55	5.85	4.90	5.90	4.95	5.25	4.95
50	4	30	8.08	8.58	9.18	8.48	9.58	8.65	9.23

Contd.....

APPENDIX 3.XV

AE SCORES OF SUBJECTS ON VERTICAL LOAD IN EXPERIMENT 3.5

SIGNIFICANCE

CONDITIONS			SUBJECTS						
AI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.45	1.13	1.39	1.45	1.89	1.80	1.70
0	0	20	1.98	1.89	1.86	1.89	2.19	1.68	2.60
0	0	30	3.03	3.58	2.53	3.30	3.39	2.43	3.55
0	2	10	1.69	1.53	1.10	1.95	2.05	1.43	2.05
0	2	20	2.10	1.88	2.08	1.55	2.33	2.15	2.40
0	2	30	2.85	3.75	2.70	2.85	3.40	2.88	3.50
0	4	10	1.73	1.60	1.20	1.93	1.68	1.53	1.75
0	4	20	2.10	2.25	1.80	2.00	2.03	1.89	2.20
0	4	30	3.43	3.65	2.93	3.53	3.28	2.53	3.25
15	0	10	2.58	2.38	2.28	2.98	2.85	3.18	3.00
15	0	20	3.83	3.20	2.78	3.65	3.65	3.10	3.75
15	0	30	5.90	7.08	4.25	5.00	5.08	5.23	5.75
15	2	10	2.73	2.68	2.13	2.78	2.93	2.78	2.90
15	2	20	3.68	3.40	2.60	3.73	3.53	3.13	3.43
15	2	30	5.78	6.40	3.65	5.65	5.48	4.33	5.43
15	4	10	2.83	2.78	2.43	3.18	2.38	3.40	2.70
15	4	20	3.53	3.10	2.83	3.50	3.58	2.53	4.13
15	4	30	5.43	6.73	4.75	4.78	4.93	4.45	5.53
50	0	10	4.73	4.23	3.83	4.50	4.38	3.83	4.70
50	0	20	5.40	5.93	4.70	5.88	5.00	5.73	5.53
50	0	30	7.95	9.18	7.28	7.43	8.20	8.23	6.43
50	2	10	4.58	4.33	4.35	4.38	4.05	4.30	4.53
50	2	20	5.53	5.33	5.35	5.00	4.60	5.03	5.20
50	2	30	7.85	9.23	7.08	8.05	9.53	8.33	6.70
50	4	10	4.38	4.00	4.25	4.30	4.73	4.43	4.48
50	4	20	5.55	5.85	4.90	5.30	4.95	5.13	4.98
50	4	30	8.08	8.58	9.16	8.48	9.58	8.63	6.83

Contd....

3.50

APPENDIX 3.XV (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.08	0.25	0.15	0.20	0.28	0.18	0.30
0	0	20	0.25	0.70	0.28	0.45	0.55	0.53	0.83
0	0	30	1.45	1.25	1.23	1.75	1.45	1.83	0.98
0	2	10	1.80	1.43	1.98	1.75	1.80	1.70	1.83
0	2	20	1.63	1.85	1.60	2.28	1.95	1.85	1.90
0	2	30	2.78	3.20	2.78	3.33	3.15	3.28	2.78
0	4	10	2.93	3.05	3.13	3.70	2.95	3.00	3.63
0	4	20	3.08	3.48	3.20	3.35	3.35	3.68	3.63
0	4	30	4.20	4.53	4.83	5.03	4.43	3.93	4.93
15	0	10	0.18	0.20	0.25	0.15	0.25	0.18	0.25
15	0	20	0.80	0.85	0.68	0.70	0.68	0.60	0.65
15	0	30	1.60	1.60	1.80	1.55	1.38	2.00	1.23
15	2	10	1.35	1.40	1.53	1.65	1.30	1.43	1.68
15	2	20	2.03	1.63	2.15	1.93	1.98	2.25	2.30
15	2	30	2.83	2.43	2.75	3.28	3.10	3.13	3.23
15	4	10	3.40	2.95	2.80	3.10	3.03	3.13	2.88
15	4	20	3.23	3.03	2.83	3.95	3.55	3.35	3.40
15	4	30	4.48	4.23	4.48	4.88	5.18	5.60	4.93
50	0	10	0.28	0.15	0.25	0.53	0.20	0.25	0.23
50	0	20	0.68	0.43	0.45	0.73	0.68	0.45	0.65
50	0	30	1.28	1.30	1.15	1.83	1.28	1.68	1.23
50	2	10	2.38	1.85	1.80	2.15	2.00	1.83	1.95
50	2	20	1.95	2.30	2.48	2.65	2.55	2.78	2.33
50	2	30	3.35	3.83	3.58	3.28	2.95	3.50	3.53
50	4	10	3.35	3.10	3.18	3.18	2.88	3.03	2.98
50	4	20	3.33	3.35	3.55	3.63	3.15	3.63	3.98
50	4	30	4.48	5.15	4.70	5.30	5.33	5.65	5.18

Contd...

CONDITIONS			DISTANCE						
RI (sec)	Pus.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.08	0.25	0.15	0.10	0.28	0.18	0.30
0	0	20	0.85	0.70	0.38	0.45	0.35	0.23	0.43
0	0	30	1.45	1.29	1.03	1.13	1.45	1.83	1.08
0	2	10	1.80	1.45	1.38	1.15	1.80	1.70	1.83
0	2	20	1.63	1.85	1.60	1.48	1.95	1.83	1.90
0	2	30	2.76	3.20	2.78	2.33	3.15	2.28	2.78
0	4	10	2.93	3.08	3.13	3.70	3.90	3.10	3.03
0	4	20	3.08	3.48	3.40	3.25	3.35	3.48	3.63
0	4	30	4.20	4.53	4.83	5.03	4.43	3.73	4.23
15	0	10	0.13	0.20	0.25	0.15	0.43	0.15	0.43
15	0	20	0.90	0.85	0.63	0.70	0.68	0.60	0.68
15	0	30	1.60	1.60	1.40	1.35	1.33	2.04	1.33
15	2	10	1.35	1.20	1.33	1.05	1.30	1.43	1.48
15	2	20	2.03	1.83	2.13	1.93	1.78	2.33	2.33
15	2	30	2.83	2.43	2.73	3.28	3.10	3.13	3.33
15	4	10	3.20	2.35	2.80	3.10	3.03	3.13	3.38
15	4	20	3.23	3.03	3.43	3.35	3.33	3.33	3.20
15	4	30	4.48	4.23	4.48	4.38	3.78	3.90	4.23
50	0	10	0.28	0.15	0.25	0.33	0.20	0.23	0.23
50	0	20	0.68	0.43	0.43	0.73	0.68	0.43	0.68
50	0	30	1.38	1.30	1.15	1.83	1.28	1.48	1.23
50	2	10	2.38	1.85	1.80	2.15	2.00	1.83	1.93
50	2	20	1.95	2.20	2.48	2.63	2.55	2.78	2.33
50	2	30	3.35	3.83	3.38	3.38	2.05	3.30	3.33
50	4	10	3.35	3.10	3.18	3.13	3.23	3.03	3.23
50	4	20	3.33	3.35	3.39	3.63	3.15	3.03	3.08
50	4	30	4.48	5.15	4.70	5.30	5.13	5.03	5.18

3.51

QPPENDIX 3.XV (CONTD.)

BLIND

LOCATION

CONDITIONS			SUBJECT						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	2.33	2.30	3.55	1.95	2.50	1.80	1.68
0	0	20	2.83	2.93	2.53	1.50	1.95	1.40	1.03
0	0	30	1.65	1.40	1.18	1.10	1.75	1.80	0.05
0	2	10	2.90	3.20	2.78	2.68	2.65	1.48	3.73
0	2	20	3.25	2.13	2.28	2.50	2.03	1.03	3.15
0	2	30	1.85	1.38	2.60	3.25	2.18	1.38	3.45
0	4	10	2.48	3.35	3.25	2.45	3.58	2.88	5.00
0	4	20	3.18	2.70	3.55	2.10	2.98	2.13	4.83
0	4	30	1.95	2.03	3.38	2.25	2.50	3.00	2.95
15	0	10	1.83	2.25	2.88	1.30	2.10	1.70	1.48
15	0	20	1.90	2.18	2.10	0.70	1.10	1.85	1.55
15	0	30	1.80	1.30	0.75	0.83	0.95	2.18	0.50
15	2	10	1.58	2.73	4.43	3.25	3.15	2.88	3.65
15	2	20	1.55	1.90	2.25	2.20	2.00	1.43	2.48
15	2	30	2.03	3.80	2.15	1.85	2.50	3.00	2.23
15	4	10	1.35	4.35	3.30	2.25	4.38	4.35	5.33
15	4	20	2.05	2.00	2.23	2.58	2.23	1.00	4.00
15	4	30	1.78	4.05	1.48	3.43	1.55	1.93	3.75
50	0	10	1.35	2.00	3.73	1.73	3.63	3.20	1.50
50	0	20	1.18	1.50	2.48	1.03	2.63	2.05	0.95
50	0	30	2.88	2.78	1.05	3.08	1.68	1.68	0.85
50	2	10	1.90	3.95	4.80	2.70	4.40	5.88	3.13
50	2	20	1.43	2.28	2.18	2.05	2.08	1.80	3.15
50	2	30	2.25	4.40	2.83	1.00	2.70	3.03	2.88
50	4	10	1.83	4.98	5.70	3.08	4.35	2.68	4.60
50	4	20	2.15	2.73	2.48	2.38	3.40	2.48	4.13
50	4	30	1.75	5.18	2.50	3.45	3.55	1.70	2.73

Contd...

3.52

APPENDIX 3.XV (CONTD.)

DISTANCE

CONDITIONS			SUBJECT						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	3.30	2.38	1.58	1.95	3.10	1.50	1.80
0	0	20	3.55	1.28	2.43	2.23	1.63	2.00	2.00
0	0	30	3.08	5.40	4.15	5.50	5.73	3.25	4.58
0	2	10	3.68	2.75	0.48	1.40	1.23	1.93	2.08
0	2	20	2.35	3.38	2.18	3.20	3.13	3.03	2.65
0	2	30	6.38	4.98	3.65	5.95	7.03	5.20	4.33
0	4	10	4.23	2.75	1.35	2.00	2.50	1.70	2.05
0	4	20	4.45	2.05	0.90	2.25	4.63	3.08	2.60
0	4	30	8.15	7.58	5.58	4.85	8.15	5.30	3.20
15	0	10	5.80	3.18	2.33	3.03	4.73	3.65	3.65
15	0	20	4.35	3.08	2.70	2.50	1.98	3.43	4.18
15	0	30	2.50	8.28	5.18	7.33	6.33	6.10	6.85
15	2	10	2.73	2.85	1.53	3.23	1.18	3.40	4.38
15	2	20	5.23	2.43	4.58	3.30	3.78	6.23	4.68
15	2	30	8.78	8.35	9.15	6.10	9.48	7.18	7.18
15	4	10	4.65	2.93	2.20	2.63	1.43	2.68	3.78
15	4	20	5.85	3.65	4.43	4.10	3.70	3.00	3.35
15	4	30	13.25	8.18	7.53	5.00	10.35	8.10	8.05
50	0	10	6.65	3.40	3.73	4.33	4.13	3.40	5.25
50	0	20	5.38	2.15	2.78	2.63	1.88	4.75	6.55
50	0	30	4.33	9.68	8.63	8.40	8.18	12.13	12.55
50	2	10	4.38	4.05	2.38	5.30	2.95	5.55	7.63
50	2	20	5.93	4.90	4.85	4.25	1.88	6.30	5.85
50	2	30	9.95	10.33	8.63	8.20	10.73	9.50	10.45
50	4	10	3.80	4.25	2.80	6.53	2.00	6.00	6.40
50	4	20	3.88	1.70	4.68	3.95	5.05	5.15	6.48
50	4	30	12.65	8.53	7.00	8.85	9.83	11.38	12.30

3.53

APPENDIX 3.XVI

VE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.20	0.99	0.31	0.32	0.24	0.29	0.27
0	0	20	1.69	1.62	1.52	1.65	1.95	0.62	2.18
0	0	30	0.33	0.66	2.46	2.79	0.40	0.61	0.50
0	2	10	0.33	0.39	0.19	0.27	0.17	0.53	0.36
0	2	20	1.76	1.85	1.90	1.60	2.34	1.98	2.40
0	2	30	0.38	0.76	2.77	0.77	0.92	2.28	0.33
0	4	10	0.29	0.42	0.87	0.30	1.52	0.29	0.27
0	4	20	0.30	2.10	0.14	2.00	0.36	1.85	2.23
0	4	30	0.58	0.41	2.37	0.44	0.68	2.22	0.40
15	0	10	2.18	2.41	1.64	0.91	0.45	0.37	0.07
15	0	20	0.22	3.22	2.80	3.10	3.27	3.11	3.75
15	0	30	0.71	0.94	3.60	0.39	0.67	0.73	0.76
15	2	10	2.43	2.50	0.62	0.36	0.50	2.37	0.19
15	2	20	3.14	0.83	2.61	0.82	3.09	3.15	3.32
15	2	30	4.95	0.13	2.90	0.42	0.73	4.56	4.41
15	4	10	0.58	2.42	0.25	0.65	0.41	2.92	0.81
15	4	20	3.68	3.12	2.48	3.50	3.00	0.23	3.66
15	4	30	4.45	0.38	4.33	0.52	0.21	3.76	1.50
50	0	10	0.50	0.73	0.78	0.43	0.46	3.69	0.62
50	0	20	5.47	1.06	4.71	1.28	0.76	4.28	5.49
50	0	30	0.99	0.25	1.54	0.43	1.95	0.53	0.98
50	2	10	3.57	0.43	0.67	0.49	0.09	0.39	3.86
50	2	20	4.55	0.60	5.35	0.45	4.20	0.89	5.21
50	2	30	0.86	0.55	1.98	0.53	1.01	0.24	0.46
50	4	10	0.69	0.28	0.54	3.99	4.13	0.44	1.15
50	4	20	0.58	0.83	4.17	0.39	4.98	4.65	0.21
50	4	30	1.19	0.29	0.47	0.36	1.55	0.74	0.68

Contd...

APPENDIX 3.XVI

VE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.5

LOCATION	CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	1.20	0.99	0.34	0.32	0.24	0.29	0.27
0	0	20	1.69	1.62	1.32	1.65	1.95	0.68	2.42
0	0	30	0.33	0.66	2.46	2.79	0.40	0.61	0.46
0	2	10	0.33	0.39	0.19	0.27	0.17	0.53	0.36
0	2	20	1.76	1.85	1.90	1.60	2.34	1.98	2.40
0	2	30	0.38	0.76	2.77	0.77	0.92	2.28	0.83
0	4	10	0.29	0.42	0.27	0.30	1.32	0.29	0.27
0	4	20	0.30	2.10	0.14	2.10	0.36	1.65	2.43
0	4	30	0.38	0.21	2.37	0.44	0.98	2.32	0.40
15	0	10	2.18	2.47	1.64	0.91	0.45	0.37	0.37
15	0	20	0.22	3.22	2.80	3.10	3.27	3.13	3.55
15	0	30	0.71	0.94	3.60	0.39	0.67	0.73	0.76
15	2	10	2.43	2.50	0.62	0.36	0.30	0.37	0.41
15	2	20	3.14	0.83	2.61	0.62	3.09	3.15	3.58
15	2	30	4.95	0.13	2.90	0.42	0.73	0.36	0.47
15	4	10	0.38	2.42	0.25	0.65	0.41	2.38	0.21
15	4	20	3.68	3.18	2.40	3.50	3.31	0.23	3.68
15	4	30	4.45	0.38	1.33	0.58	0.27	3.38	1.62
50	0	10	0.30	0.73	0.78	0.43	0.16	0.69	0.62
50	0	20	5.47	1.06	4.77	1.22	0.78	4.88	5.43
50	0	30	0.99	0.25	1.54	0.45	1.38	0.33	0.38
50	2	10	3.37	0.43	0.67	0.43	0.09	0.34	0.45
50	2	20	4.55	0.80	5.35	0.65	6.01	0.84	5.21
50	2	30	0.86	0.39	1.98	0.23	1.01	0.24	0.26
50	4	10	0.69	0.48	0.54	3.29	4.13	0.42	1.15
50	4	20	0.50	0.88	4.17	0.39	4.98	4.65	4.27
50	4	30	1.19	0.29	0.42	0.38	1.55	0.24	0.86

Contd...

3.54

APPENDIX 3.XVI (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.08	0.26	0.17	0.21	0.29	0.18	0.19
0	0	20	0.36	0.27	0.18	0.39	0.57	0.79	0.15
0	0	30	1.07	0.76	0.35	1.55	1.15	0.20	1.25
0	2	10	0.43	1.44	0.59	1.64	0.35	0.25	1.55
0	2	20	1.63	1.69	1.42	2.01	1.97	1.63	1.77
0	2	30	2.36	0.89	2.78	0.47	2.83	0.79	2.36
0	4	10	0.29	0.15	0.38	0.32	2.43	0.35	0.27
0	4	20	2.70	3.48	2.90	0.23	3.35	3.42	0.55
0	4	30	4.20	0.79	0.25	0.72	4.01	0.77	0.44
15	0	10	0.20	0.24	0.25	0.19	0.09	0.22	0.26
15	0	20	0.85	0.90	0.73	0.55	0.68	0.55	0.50
15	0	30	1.50	1.35	1.86	1.23	0.49	0.61	1.27
15	2	10	1.12	1.43	1.30	1.45	1.31	1.09	0.28
15	2	20	1.76	1.38	2.17	1.43	0.38	1.90	1.97
15	2	30	2.59	0.35	0.56	0.48	0.42	0.33	2.93
15	4	10	0.16	0.38	0.29	2.71	0.29	0.41	0.29
15	4	20	3.23	2.56	2.41	0.27	3.56	3.03	0.43
15	4	30	0.71	0.41	3.74	0.29	0.94	0.80	0.76
50	0	10	0.19	0.21	0.21	0.55	0.20	0.22	0.15
50	0	20	0.68	0.23	0.44	0.61	0.20	0.51	0.68
50	0	30	1.08	0.16	0.38	0.18	0.53	0.58	0.55
50	2	10	0.24	0.18	0.26	1.79	0.63	0.77	0.34
50	2	20	1.73	0.22	0.08	2.32	2.33	0.60	1.95
50	2	30	0.33	0.38	0.78	0.67	0.05	0.44	0.63
50	4	10	0.68	2.70	0.50	2.96	0.34	0.62	0.11
50	4	20	3.34	2.84	3.27	0.31	0.50	0.76	0.53
50	4	30	0.33	0.63	0.67	0.35	0.34	0.77	0.93

Contd....

3.55

APPENDIX 3.XVI (CONTD.)

BLIND

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.79	0.35	0.85	0.78	0.39	0.32	0.22
0	0	20	1.11	0.23	1.19	1.27	0.64	0.51	0.65
0	0	30	2.24	1.17	1.07	1.37	2.17	1.65	0.09
0	2	10	0.20	0.89	1.47	0.90	0.63	0.76	0.81
0	2	20	0.62	2.35	0.64	2.38	1.43	1.09	0.55
0	2	30	1.97	1.40	2.32	0.91	2.28	0.18	0.58
0	4	10	0.71	3.24	0.09	0.36	0.72	0.26	0.79
0	4	20	1.06	1.21	0.48	1.83	2.97	0.13	4.88
0	4	30	1.76	0.96	3.64	2.39	0.83	2.11	2.05
15	0	10	0.40	0.81	0.94	0.67	1.69	0.82	0.87
15	0	20	1.44	1.71	0.97	0.78	0.72	0.61	0.35
15	0	30	1.99	1.14	0.80	0.75	1.00	1.76	0.22
15	2	10	0.78	0.62	0.44	0.67	0.77	0.88	0.62
15	2	20	1.64	1.09	2.15	0.48	1.47	0.94	2.46
15	2	30	2.30	1.70	2.36	1.55	0.23	2.35	2.07
15	4	10	0.98	1.32	1.05	0.40	0.35	1.15	0.68
15	4	20	2.01	1.51	2.11	2.00	1.84.	1.12	3.47
15	4	30	1.83	1.87	1.69	3.21	0.55	1.86	1.07
50	0	10	1.19	0.81	1.75	1.97	1.89	1.02	1.30
50	0	20	0.95	1.53	2.26	0.99	0.79	2.10	0.99
50	0	30	2.88	0.91	1.19	3.46	0.36	1.61	0.82
50	2	10	1.06	0.98	1.22	1.36	1.56	0.57	0.54
50	2	20	1.64	2.42	2.30	2.18	1.42	0.51	0.46
50	2	30	1.08	0.42	3.19	1.23	1.83	2.75	2.58
50	4	10	2.40	2.17	0.74	0.33	1.06	0.36	0.60
50	4	20	1.04	2.66	0.93	1.60	2.25	1.78	0.43
50	4	30	1.79	0.54	1.53	3.22	0.99	0.31	2.74

Contd..

3.56

APPENDIX 3.XVI (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
SI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.57	1.56	1.17	1.11	0.89	0.59	0.34
0	0	20	1.37	0.94	1.08	2.36	0.71	1.46	0.35
0	0	30	2.97	1.38	1.49	0.98	0.49	1.65	0.64
0	2	10	3.70	2.38	0.18	1.04	0.93	2.15	0.38
0	2	20	1.84	1.26	1.61	2.68	1.74	2.95	2.08
0	2	30	1.68	1.04	1.65	1.95	1.01	2.02	0.78
0	4	10	1.07	1.82	1.51	0.45	3.30	0.54	0.22
0	4	20	0.67	2.60	0.83	2.37	0.46	3.22	2.44
0	4	30	0.80	2.67	1.41	1.87	0.30	4.10	1.32
15	0	10	1.14	2.08	1.23	0.93	1.30	0.75	0.61
15	0	20	1.61	2.84	1.48	2.59	1.95	3.33	3.42
15	0	30	2.56	1.29	0.76	1.31	0.66	0.57	1.18
15	2	10	2.46	0.58	0.79	1.14	0.94	0.46	1.04
15	2	20	1.54	1.75	1.33	3.49	0.80	5.47	1.44
15	2	30	1.66	1.32	0.38	3.75	0.86	1.48	1.93
15	4	10	3.57	0.62	1.81	1.18	0.86	1.47	0.29
15	4	20	1.48	3.43	1.24	4.18	2.32	2.83	3.45
15	4	30	1.48	1.69	1.69	2.80	1.54	1.82	0.93
50	0	10	0.17	1.63	2.38	2.20	1.20	3.23	0.59
50	0	20	4.01	1.45	3.72	2.63	2.06	1.44	0.67
50	0	30	3.44	1.02	1.98	2.02	3.13	0.74	1.26
50	2	10	1.02	1.40	2.02	1.15	0.74	1.87	1.39
50	2	20	1.08	1.47	1.69	2.66	0.64	5.26	0.52
50	2	30	2.36	2.77	3.15	2.17	1.34	0.79	0.75
50	4	10	3.25	2.31	0.46	1.52	1.19	0.95	1.03
50	4	20	0.54	1.97	1.10	2.67	1.53	0.65	0.89
50	4	30	1.31	1.93	2.90	4.25	0.22	1.14	0.46

APPENDIX 3.XVII

CE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	0.85	0.58	1.33	1.45	1.83	1.60	1.70
0	0	20	-1.07	0.88	1.13	-0.93	1.03	1.68	1.45
0	0	30	-3.03	-3.58	0.88	-1.83	-3.35	-2.43	-3.55
0	2	10	1.63	1.53	1.10	1.95	2.05	1.43	2.05
0	2	20	-1.15	-0.58	0.88	-0.35	0.18	0.90	0.20
0	2	30	-2.85	-3.75	0.00	-2.85	-3.40	-0.23	-3.50
0	4	10	1.73	1.60	0.90	1.93	0.73	1.55	1.75
0	4	20	-2.10	-0.90	1.80	0.10	2.03	-0.30	0.45
0	4	30	-3.43	-3.65	-1.78	-3.25	-3.28	-1.35	-3.25
15	0	10	1.38	0.33	1.73	2.98	2.85	3.18	3.00
15	0	20	-3.83	-0.35	-0.08	-1.95	1.65	0.10	0.18
15	0	30	-5.90	-7.08	-2.30	-5.60	-5.08	-5.23	-5.75
15	2	10	1.28	1.08	2.13	2.78	2.93	1.48	2.90
15	2	20	-1.93	-3.40	-0.10	-3.73	-1.75	0.10	-1.53
15	2	30	-3.03	-6.40	-2.40	-5.65	-5.48	0.80	-3.23
15	4	10	2.83	1.38	2.43	3.18	2.98	1.85	2.80
15	4	20	-0.10	-0.15	1.43	0.10	1.98	2.55	1.93
15	4	30	-3.20	-6.75	2.00	-4.78	-4.95	-2.50	-5.55
50	0	10	4.73	4.28	3.85	4.50	4.38	1.48	-4.70
50	0	20	0.00	-5.95	0.40	-5.88	5.00	3.18	3.15
50	0	30	-7.95	-9.18	-7.28	-7.45	-9.20	-8.20	-8.23
50	2	10	2.98	4.33	4.35	4.38	4.05	4.50	2.48
50	2	20	-3.23	-5.33	-0.25	-5.60	-2.05	5.83	0.05
50	2	30	-2.85	-9.33	-7.08	-8.05	-9.53	-8.33	-8.70
50	4	10	4.38	4.00	4.25	3.00	2.33	4.25	4.80
50	4	20	-5.55	-5.85	-2.60	-5.90	-0.30	2.55	-4.95
50	4	30	-8.08	-8.58	-9.18	-8.48	-9.50	-8.65	-9.23

Contd....

APPENDIX 3.XVII (CONTD.)

RI (sec.)	P.A.	T (cm)	DISTANCE 1	2	3	4	5	6	7
0	0	10	0.75	0.20	0.15	0.15	0.18	0.18	0.30
0	0	20	0.05	0.70	0.28	0.25	-0.25	-0.53	0.83
0	0	30	-1.05	-1.20	-1.23	-0.85	-0.95	-1.83	-0.28
0	2	10	1.85	0.13	1.98	0.70	1.80	1.70	0.98
0	2	20	0.18	0.85	-0.75	-1.18	-0.30	0.95	-0.75
0	2	30	-1.53	-3.20	-0.28	-3.33	-1.40	-3.28	-1.48
0	4	10	2.93	3.05	3.13	3.70	1.70	3.00	3.63
0	4	20	-1.48	0.03	-1.45	-3.35	-0.45	-1.43	-3.63
0	4	30	-0.25	-4.53	-4.83	-5.03	-2.03	-7.93	-4.93
15	0	10	0.18	-0.20	0.25	0.00	0.25	0.08	0.25
15	0	20	0.10	-0.20	0.13	0.50	-0.23	-0.30	0.45
15	0	30	0.60	-1.00	-0.10	-1.05	-1.38	-2.00	-0.33
15	2	10	0.85	-0.10	0.93	0.85	0.05	1.04	1.68
15	2	20	1.03	-0.88	-0.60	0.18	-1.98	-1.30	1.30
15	2	30	-1.18	-2.43	-2.75	-3.28	-3.10	-3.13	-1.38
15	4	10	3.40	2.95	2.80	1.55	3.03	3.13	2.88
15	4	20	-0.48	-1.63	-1.53	-3.95	0.15	-1.50	-3.40
15	4	30	-4.48	-4.23	-2.48	-4.88	-5.18	-5.60	-4.93
50	0	10	0.28	0.15	0.25	0.18	0.20	01.5	0.23
50	0	20	0.28	-0.43	-0.15	-0.43	-0.68	0.10	0.00
50	0	30	-0.82	-1.30	-1.15	-1.85	-1.28	-1.68	-1.23
50	2	10	2.38	1.85	1.80	1.30	2.00	0.68	1.95
50	2	20	0.95	-2.30	-2.48	-1.40	-1.25	-2.78	-1.28
50	2	30	-3.35	-3.83	-3.58	-3.28	-2.95	-3.50	-3.53
50	4	10	3.33	1.60	3.18	1.28	2.88	3.03	2.98
50	4	20	0.33	-1.85	-1.45	-3.63	-3.15	-3.63	-3.98
50	4	30	-4.48	-5.15	-4.70	-5.30	-5.33	-5.65	-5.18

Contd.....

3.59

APPENDIX 3.XVII (CONTD.)

BLIND

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	2.33	2.30	3.55	1.95	2.50	1.80	1.68
0	0	20	2.83	2.93	2.53	1.50	1.95	1.40	1.03
0	0	30	0.70	0.80	0.58	0.55	0.15	-0.80	-0.05
0	2	10	2.90	3.20	2.78	2.68	2.65	1.48	3.73
0	2	20	3.25	0.53	2.28	1.10	1.78	0.18	3.15
0	2	30	-0.50	-0.08	1.35	3.25	0.13	-1.38	3.45
0	4	10	2.48	1.35	3.25	2.45	3.58	2.88	5.00
0	4	20	3.18	2.70	3.55	1.20	1.78	2.13	0.03
0	4	30	1.90	-2.03	-0.48	-0.15	-2.50	-2.75	-2.45
15	0	10	1.83	2.25	2.88	1.30	2.05	1.70	1.48
15	0	20	1.65	1.43	2.10	0.35	1.10	1.93	1.55
15	0	30	0.75	-0.85	-0.25	-0.53	-0.65	-1.38	-0.50
15	2	10	1.58	2.73	4.43	3.25	3.15	2.88	3.65
15	2	20	1.00	-1.90	0.80	2.20	2.00	1.43	-0.73
15	2	30	0.63	-3.80	-0.25	-1.35	-2.50	- 2.05	-0.93
15	4	10	1.10	4.35	3.30	2.23	4.38	4.35	5.33
15	4	20	1.40	-1.40	0.93	1.73	1.78	0.70	2.00
15	4	30	-0.63	-4.05	-0.93	-2.03	-1.55	-0.83	-3.75
50	0	10	1.35	2.00	3.73	1.38	3.63	3.20	0.75
50	0	20	1.18	0.15	2.18	-0.38	2.63	0.45	0.45
50	0	30	1.33	-2.78	0.05	-0.63	-1.68	-1.43	-0.35
50	2	10	1.90	3.95	4.80	2.70	4.40	5.88	3.13
50	2	20	0.53	-0.18	-0.93	0.20	1.78	1.80	3.15
50	2	30	2.25	-4.40	-0.68	-0.50	-2.40	-1.38	-2.03
50	4	10	1.83	4.98	5.70	3.08	4.35	2.68	4.60
50	4	20	2.15	1.18	2.48	2.10	3.40	2.48	4.13
50	4	30	0.70	-5.18	-2.50	-2.05	-3.55	-1.70	-0.53

Contd...

SITING

LOCALITIES										
RL (sec)	P.A.	I (cm)	1	2	3	4	5	6	7
0	0	10	2.33	2.30	3.55	1.95	2.30	1.80	1.60
0	0	20	2.89	0.99	2.53	1.53	1.85	1.40	1.43
0	0	30	0.70	0.80	0.34	0.55	0.15	-0.80	-0.09
0	2	10	2.90	3.80	2.78	2.48	2.65	1.82	3.70
0	2	20	3.25	0.53	2.28	1.10	1.78	2.10	3.10
0	2	30	-0.50	-0.08	1.35	2.25	0.13	-1.30	3.42
0	4	10	2.48	1.35	3.25	2.45	3.58	2.98	5.-
0	4	20	3.18	2.70	3.55	1.20	1.75	2.15	4.02
0	4	30	1.90	-2.10	-1.48	-1.15	-2.50	-2.75	-4.72
15	0	10	1.89	2.25	2.38	1.30	2.05	1.70	1.82
15	0	20	1.65	1.49	2.10	0.35	1.10	1.73	1.22
15	0	30	0.75	-0.85	-0.25	-0.35	-0.65	-1.30	-0.52
15	2	10	1.58	2.73	1.43	3.25	3.15	2.88	3.48
15	2	20	1.00	-1.90	0.80	2.20	2.-	1.43	-1.77
15	2	30	0.69	-3.80	-0.25	-1.35	-4.-	-2.15	-1.77
15	4	10	1.10	4.35	3.30	2.23	4.30	4.35	5.23
15	4	20	1.40	-1.40	0.93	1.73	1.78	1.73	2.48
15	4	30	-0.63	-4.05	-0.93	-3.03	-1.55	-4.03	-3.98
30	0	10	1.35	2.-	2.73	1.38	2.43	2.20	1.73
30	0	20	1.18	0.15	2.13	-0.32	0.13	0.45	0.42
30	0	30	1.23	-2.73	0.25	-1.68	-1.60	-1.42	-1.15
30	2	10	1.90	3.05	4.30	1.-	2.-	2.58	2.03
30	2	20	0.53	-0.13	-0.20	1.-	1.78	1.50	2.12
30	2	30	0.25	-2.40	-0.65	-0.-	-1.-	-1.25	-0.72
30	4	10	1.83	4.20	3.75	1.58	2.58	2.08	2.80
30	4	20	2.15	1.78	2.48	2.10	2.20	2.-	2.43
30	4	30	0.70	-3.18	-2.50	-2.58	-3.55	-1.70	-0.60

Contd...

3.60

APPENDIX 3.XVII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (cm)	1	2	3	4	5	6	7
0	0	10	3.30	2.38	1.18	1.95	3.10	1.50	1.80
0	0	20	3.55	-0.93	-2.43	-0.73	-1.03	1.50	-2.00
0	0	30	-2.43	-5.40	-4.15	-5.50	-5.73	-3.25	-4.58
0	2	10	1.08	1.80	0.48	1.10	0.93	0.28	2.08
0	2	20	-1.60	-3.38	-1.63	-2.00	3.13	-2.13	-1.75
0	2	30	-6.38	-4.98	-3.65	-5.95	-7.03	-5.20	-4.33
0	4	10	4.23	2.75	1.10	2.00	0.65	1.70	2.05
0	4	20	-4.45	0.90	-0.90	0.00	-4.63	-0.58	1.10
0	4	30	-8.15	-7.58	-5.58	-4.85	-8.15	-5.30	-3.20
15	0	10	5.80	2.78	2.33	3.03	4.73	3.65	3.65
15	0	20	4.35	-1.73	-2.70	-0.60	-0.88	-1.18	-2.68
15	0	30	-1.20	-8.28	-5.18	-7.33	-6.33	-6.10	-6.85
15	2	10	1.68	2.85	1.53	3.23	-1.18	3.40	4.38
15	2	20	-5.23	-2.08	-4.58	-1.70	-3.78	-3.53	-4.68
15	2	30	-8.78	-8.35	-9.15	-6.10	-9.48	-7.18	-7.18
15	4	10	2.20	2.93	1.70	2.65	1.43	2.68	3.78
15	4	20	-5.85	-2.65	-4.43	-0.90	-3.45	-1.15	-0.25
15	4	30	-13.25	-8.18	-7.53	-5.00	-10.35	-8.10	-8.05
50	0	10	6.65	3.40	3.53	6.33	4.13	1.65	5.25
50	0	20	3.98	-1.90	1.13	-1.38	1.23	-4.75	-6.55
50	0	30	-2.78	-9.68	-8.63	-8.40	-8.18	-12.13	-12.55
50	2	10	4.38	4.05	2.03	5.30	2.95	5.55	7.63
50	2	20	-5.93	-4.90	-4.85	-4.25	-1.88	-3.55	-5.85
50	2	30	-9.95	-10.33	-8.63	-8.20	-10.73	-9.50	-10.45
50	4	10	2.45	4.25	2.80	6.53	2.00	6.00	6.40
50	4	20	-3.88	-0.05	-4.68	-3.95	-5.05	-5.15	-6.48
50	4	30	-12.65	-8.53	-7.00	-8.85	-9.83	-11.38	-12.30

3.61

APPENDIX 3.XVIII

AE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	m5	6	7
0	0	30	0.75	0.25	1.00	0.50	0.50	1.50	2.50
0	0	70	1.50	1.00	2.50	1.75	2.50	0.75	6.25
0	0	110	4.25	2.75	4.75	3.50	3.75	2.75	10.00
0	2	30	5.50	6.25	4.50	4.75	5.75	7.00	8.25
0	2	70	7.75	10.50	6.75	7.00	8.00	8.50	6.75
0	2	110	10.00	8.75	8.50	11.25	10.50	11.75	12.00
0	4	30	10.25	12.50	9.75	9.00	10.25	13.75	10.00
0	4	70	12.75	12.25	12.00	13.00	13.25	14.25	7.25
0	4	110	16.75	16.00	19.00	17.00	18.50	17.50	11.75
15	0	30	0.50	1.50	0.50	1.00	1.25	1.50	1.00
15	0	70	1.75	1.75	1.75	1.50	2.00	1.25	4.50
15	0	110	4.00	3.25	4.50	4.25	4.25	1.00	8.25
15	2	30	6.00	8.25	4.75	5.25	5.00	6.75	13.75
15	2	70	8.25	9.75	7.75	8.00	9.00	11.25	7.25
15	2	110	10.00	8.00	10.75	10.50	11.50	11.50	17.25
15	4	30	10.25	14.00	9.25	8.75	11.00	14.75	13.75
15	4	70	12.25	13.25	10.75	12.00	13.50	11.00	14.00
15	4	110	16.75	13.25	16.00	16.25	18.50	19.25	18.00
50	0	30	0.50	2.50	0.75	0.75	0.50	1.50	2.50
50	0	70	2.75	4.50	3.25	2.25	3.00	2.75	4.75
50	0	110	4.25	2.00	4.50	4.75	4.00	4.00	6.50
50	2	30	6.25	8.00	4.50	5.25	5.75	10.75	12.00
50	2	70	8.00	8.50	8.00	8.25	9.25	9.00	10.00
50	2	110	12.25	12.00	11.00	11.00	13.25	10.75	19.50
50	4	30	10.00	18.25	9.50	10.25	10.50	14.25	18.25
50	4	70	13.50	12.50	11.75	12.50	13.75	13.25	21.00
50	4	110	16.75	13.75	17.00	16.75	18.75	19.00	21.75

Contd...

APPENDIX 3.XVIII

AS SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.5

BIGHTED

LOCATION

CONDITIONS			SUBJECTS							
RI (sec)	P.A.	I (d-e.)	1	2	3	4	5	6	7	
0	0	30	0.75	0.25	1.00	0.50	0.50	1.50	2.50	
0	0	70	1.50	1.00	3.25	1.75	2.50	0.75	6.25	
0	0	110	4.25	2.75	4.75	3.50	3.75	2.75	10.00	
0	2	30	5.50	6.25	4.50	4.75	5.75	7.00	6.25	
0	2	70	7.75	10.50	6.75	7.00	6.00	8.50	8.75	
0	2	110	10.00	8.75	8.50	11.25	10.50	11.75	12.00	
0	4	30	16.25	12.50	9.75	9.00	10.25	13.75	14.00	
0	4	70	18.75	13.25	12.00	13.00	13.25	14.25	7.25	
0	4	110	16.75	16.00	14.00	17.00	17.50	17.50	11.75	
15	0	30	0.50	1.50	0.50	1.00	1.25	1.50	1.00	
15	0	70	1.75	1.75	1.75	1.50	2.00	1.25	4.25	
15	0	110	4.00	3.25	4.25	4.25	4.25	1.00	6.25	
15	2	30	6.00	8.25	4.75	5.25	5.00	6.75	13.75	
15	2	70	8.25	9.75	7.75	8.00	9.00	11.25	7.25	
15	2	110	10.00	8.00	10.75	10.50	11.50	11.50	17.25	
15	4	30	10.25	14.00	9.25	8.75	11.00	14.75	13.75	
15	4	70	12.25	13.25	10.75	12.00	13.50	11.00	14.00	
15	4	110	16.75	13.25	16.00	16.25	16.50	13.25	16.00	
50	0	30	0.5	2.50	0.75	0.75	0.50	1.50	4.25	
50	0	70	2.75	4.50	3.25	3.25	3.00	2.75	4.75	
50	0	110	4.25	2.00	4.50	4.75	4.00	4.00	6.50	
50	2	30	6.25	6.00	4.50	5.25	5.75	7.25	12.75	
50	2	70	8.00	8.50	8.00	9.25	9.00	9.00	7.00	
50	2	110	12.25	12.50	11.00	11.00	13.25	11.75	13.75	
50	4	30	16.00	16.25	9.50	10.25	10.00	14.25	15.25	
50	4	70	13.50	12.50	11.75	13.00	13.25	13.25	21.25	
50	4	110	16.75	13.75	17.00	16.75	16.00	19.00	21.25	

Contd...

3.62

APPENDIX 3.XVIII (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	5	6	7
0	0	30	4.50	8.00	5.00	4.25	5.00	5.25	4.50
0	0	70	5.75	10.75	8.00	7.75	9.00	7.50	8.50
0	0	110	13.25	14.50	12.00	11.50	12.25	14.50	14.00
0	2	30	5.75	6.25	3.50	5.00	4.00	5.50	5.00
0	2	70	6.00	10.75	8.50	8.25	9.50	8.25	7.75
0	2	110	12.00	13.75	11.75	14.00	14.25	13.00	14.25
0	4	30	5.00	6.25	5.25	5.00	5.25	5.50	4.75
0	4	70	6.50	10.75	8.75	8.25	9.50	9.50	9.50
0	4	110	12.50	13.75	13.75	14.00	14.00	13.75	13.75
15	0	30	13.00	18.50	9.75	8.75	10.75	9.25	10.25
15	0	70	13.50	16.75	13.50	14.00	15.75	13.50	13.25
15	0	110	19.00	22.00	19.50	20.25	19.25	21.25	20.25
15	2	30	12.75	18.75	8.50	10.00	7.75	9.50	10.00
15	2	70	13.25	15.75	13.75	14.00	14.25	13.00	13.25
15	2	110	18.00	20.50	17.50	19.50	19.50	20.25	20.00
15	4	30	14.25	21.75	9.00	8.75	10.25	9.00	9.00
15	4	70	14.25	15.50	14.25	13.00	15.50	13.75	12.75
15	4	110	20.75	23.25	19.25	20.00	20.00	21.00	19.75
50	0	30	22.50	18.00	15.25	14.25	17.50	14.50	13.75
50	0	70	31.00	22.00	20.50	20.25	21.75	21.25	19.00
50	0	110	33.75	26.00	23.25	26.50	25.25	32.00	25.00
50	2	30	22.75	20.25	15.00	14.00	16.50	15.50	14.75
50	2	70	25.00	21.00	20.50	20.75	21.25	20.00	18.25
50	2	110	33.00	29.50	27.25	28.00	27.25	32.75	31.50
50	4	30	26.50	25.25	14.75	14.75	17.25	14.00	13.50
50	4	70	30.75	26.25	22.50	19.25	22.00	24.00	20.50
50	4	110	32.25	37.00	29.00	27.75	28.00	30.00	29.75

Contd...

3.63

APPENDIX 3.XVIII (CONTD.)

&

BLIND

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	5	6	7
0	0	30	1.75	1.75	0.75	3.75	1.25	1.25	1.25
0	0	70	4.75	1.00	1.00	2.50	1.50	1.50	2.00
0	0	110	1.75	4.50	2.00	3.25	1.25	2.00	1.50
0	2	30	2.75	6.25	2.75	11.75	7.75	5.00	2.25
0	2	70	5.50	12.00	4.50	6.00	4.00	3.75	4.25
0	2	110	3.25	9.50	5.50	9.00	4.50	5.50	7.25
0	4	30	3.25	6.00	4.25	8.75	7.00	4.75	4.75
0	4	70	4.50	6.50	3.00	10.00	8.00	5.00	10.50
0	4	110	2.75	10.75	10.50	11.25	9.75	11.00	9.25
15	0	30	1.50	3.25	3.50	2.75	3.25	2.00	1.25
15	0	70	4.50	8.00	2.25	4.75	4.50	4.00	3.00
15	0	110	6.50	4.50	6.00	5.50	4.00	2.75	6.00
15	2	30	3.75	6.75	2.75	12.75	12.75	5.50	5.00
15	2	70	6.25	8.25	4.25	6.50	6.75	7.00	7.75
15	2	110	13.50	12.00	10.25	11.25	7.25	10.00	10.25
15	4	30	11.25	11.50	6.50	9.50	7.25	10.50	6.75
15	4	70	6.50	7.75	5.75	12.00	9.75	5.75	14.75
15	4	110	11.00	15.50	9.50	12.50	9.25	7.50	11.25
50	0	30	5.25	3.75	4.00	6.00	5.50	4.50	1.25
50	0	70	6.75	5.75	3.75	7.00	4.50	5.50	4.50
50	0	110	10.00	5.50	5.75	7.25	4.75	2.50	5.00
50	2	30	7.00	9.75	6.75	15.25	15.50	11.00	2.75
50	2	70	11.25	10.50	5.50	11.50	10.50	11.50	12.75
50	2	110	15.75	23.75	8.50	12.75	7.50	16.50	12.50
50	4	30	10.00	10.50	8.75	19.25	12.50	10.25	7.25
50	4	70	8.25	9.50	11.00	10.75	10.50	13.25	11.50
50	4	110	10.50	15.50	14.25	19.00	10.00	17.25	14.75

Contd....

3.64

APPENDIX 3.XVIII (CONTD.)

DISTANCES

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	5	6	7
0	0	30	8.75	6.50	8.75	12.00	17.50	10.25	7.25
0	0	70	9.00	7.75	5.75	8.00	11.25	13.75	11.75
0	0	110	20.50	13.25	12.25	19.25	36.25	18.00	21.50
0	2	30	13.75	12.00	9.00	6.00	13.75	9.50	23.25
0	2	70	9.50	5.75	9.25	9.50	15.75	18.00	19.00
0	2	110	20.25	19.00	22.25	22.00	31.75	39.50	27.50
0	4	30	13.00	6.00	14.00	10.25	26.25	9.00	29.25
0	4	70	9.50	5.50	8.75	7.00	11.25	13.00	23.25
0	4	110	14.00	19.25	22.50	24.50	38.00	20.75	18.50
15	0	30	14.00	16.50	16.75	8.00	22.50	14.00	22.25
15	0	70	14.00	9.00	11.25	13.75	13.50	13.75	19.00
15	0	110	24.50	21.25	22.50	21.25	40.00	20.50	26.50
15	2	30	27.75	13.00	10.00	8.75	14.00	9.75	35.00
15	2	70	13.25	15.00	8.75	20.00	19.50	18.00	16.75
15	2	110	26.25	25.25	30.00	36.50	47.75	33.25	29.75
15	4	30	21.75	21.25	9.75	16.25	33.00	16.75	20.75
15	4	70	13.50	16.00	10.00	13.50	16.50	17.00	25.75
15	4	110	25.25	23.25	25.75	28.75	49.25	33.75	20.50
50	0	30	39.00	31.50	15.25	18.50	25.25	10.75	19.50
50	0	70	24.50	20.00	20.75	10.50	17.00	17.00	28.00
50	0	110	37.75	22.50	28.50	41.00	36.75	22.50	37.50
50	2	30	33.25	25.25	20.75	19.75	30.00	18.75	48.75
50	2	70	21.50	20.75	17.25	16.75	19.75	23.75	28.75
50	2	110	33.50	31.75	40.00	47.00	49.25	51.50	28.50
50	4	30	40.50	25.00	27.25	17.25	35.75	31.50	44.00
50	4	70	25.25	15.75	17.25	24.00	23.00	23.50	32.50
50	4	110	37.50	34.50	42.50	44.75	55.75	45.50	34.00

3.65

APPENDIX 3.XIX

VE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	5	6	7
0	0	30	0.83	0.43	0.71	0.71	0.50	1.12	1.66
0	0	70	1.58	1.12	2.50	1.79	2.06	0.83	6.22
0	0	110	0.83	2.28	0.83	3.57	3.42	0.83	3.24
0	2	30	0.50	1.47	0.50	0.83	0.83	5.96	3.49
0	2	70	6.50	9.01	6.80	6.87	1.22	7.70	6.50
0	2	110	0.71	7.08	1.12	0.83	8.78	9.42	1.87
0	4	30	0.43	2.50	1.48	0.00	8.53	1.48	3.94
0	4	70	1.48	9.81	10.49	11.60	11.17	4.33	7.26
0	4	110	1.09	12.79	1.87	1.00	1.50	2.29	2.86
15	0	30	0.50	1.58	0.87	0.71	1.48	1.66	0.00
15	0	70	1.92	1.92	1.09	1.87	1.41	1.79	1.66
15	0	110	3.20	2.86	0.50	1.09	3.70	1.00	1.30
15	2	30	0.71	1.92	0.83	0.83	0.71	1.48	3.77
15	2	70	0.43	1.48	1.09	6.96	1.22	1.48	7.46
15	2	110	0.71	7.55	1.30	0.50	1.12	1.80	1.48
15	4	30	1.09	14.07	1.30	0.83	1.73	2.95	3.77
15	4	70	1.09	12.03	1.09	9.85	0.87	9.55	12.81
15	4	110	1.09	12.11	1.41	0.83	2.29	2.49	2.55
50	0	30	0.71	1.87	0.43	0.83	0.50	1.50	0.87
50	0	70	2.28	4.18	2.77	1.30	0.71	1.92	5.53
50	0	110	0.43	1.41	0.50	0.43	0.71	0.71	2.29
50	2	30	0.43	1.41	0.50	0.43	1.09	9.81	2.55
50	2	70	1.00	2.06	6.69	1.09	8.23	9.06	10.77
50	2	110	0.43	3.67	1.22	9.30	1.30	3.03	4.97
50	4	30	1.22	16.50	9.01	0.43	0.87	12.28	5.76
50	4	70	11.93	10.33	1.48	0.87	12.03	11.75	5.00
50	4	110	0.83	1.48	2.35	1.30	0.83	2.12	4.18

Contd.

3.66

APPENDIX 3.XIX (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg.)	1	2	3	4	5	6	7
0	0	30	2.69	2.24	0.000	0.83	0.71	4.82	0.50
0	0	70	6.42	10.77	6.69	7.15	7.84	6.44	8.53
0	0	110	4.76	2.60	1.58	1.66	1.09	1.66	1.41
0	2	30	5.85	1.48	0.87	9.18	0.71	1.12	1.00
0	2	70	5.94	2.95	6.96	6.53	1.80	8.47	7.85
0	2	110	4.64	2.59	2.05	1.22	0.83	1.87	0.43
0	4	30	5.10	6.30	0.43	0.71	0.83	2.06	0.43
0	4	70	2.06	10.85	0.83	8.26	9.63	9.82	8.22
0	4	110	4.03	3.34	2.17	1.41	1.22	2.28	1.48
15	0	30	13.16	1.12	0.43	1.30	1.92	1.48	0.83
15	0	70	2.06	16.07	12.15	11.60	4.26	11.52	1.09
15	0	110	2.74	3.67	2.60	1.48	0.83	0.83	1.09
15	2	30	12.38	17.53	0.50	7.83	1.30	1.66	1.41
15	2	70	1.30	15.79	12.03	2.35	11.45	13.12	13.25
15	2	110	2.24	2.96	2.06	0.87	1.50	0.43	1.42
15	4	30	12.97	2.17	1.00	0.83	1.79	1.22	1.22
15	4	70	11.63	15.51	12.32	11.32	13.93	12.70	12.87
15	4	110	3.96	19.74	0.83	1.73	2.45	1.22	1.48
50	0	30	18.69	0.00	1.48	1.48	3.04	13.22	1.09
50	0	70	5.52	18.98	1.12	1.09	18.62	18.46	19.05
50	0	110	3.19	7.21	5.36	2.69	2.59	5.48	5.24
50	2	30	19.93	17.08	0.71	2.12	1.50	3.64	0.83
50	2	70	20.01	19.63	2.18	2.38	17.78	20.40	16.62
50	2	110	9.85	7.57	1.79	1.87	1.92	3.27	0.87
50	4	30	2.87	3.27	2.68	0.83	2.59	0.71	2.06
50	4	70	7.46	4.02	3.84	2.95	18.53	19.75	1.12
50	4	110	3.90	5.61	1.73	2.28	1.87	3.54	0.43

Contd.,...

3.67

APPENDIX 3.XIX (CONTD.)

LOCATION — BLIND

CONDITIONS			SUBJECT						
RI (sec)	P.A.	T (deg)	1	2	3	4	5	6	7
0	0	30	1.09	1.09	0.83	1.79	1.09	0.83	1.79
0	0	70	4.81	1.00	0.71	2.18	1.19	1.58	2.00
0	0	110	1.48	5.34	1.87	3.49	1.64	1.87	1.66
0	2	30	3.11	6.34	1.48	7.15	2.86	3.54	2.38
0	2	70	6.34	12.33	4.06	5.50	2.74	3.03	3.63
0	2	110	3.11	5.68	3.20	7.52	5.02	1.80	6.53
0	4	30	2.05	1.87	4.32	7.66	6.93	2.05	4.97
0	4	70	3.08	4.39	2.55	4.74	1.58	5.48	9.25
0	4	110	3.77	8.32	4.15	6.02	10.30	8.78	3.77
15	0	30	1.50	1.64	3.04	1.48	0.83	1.22	1.48
15	0	70	1.66	8.26	0.83	5.07	1.50	4.12	2.24
15	0	110	2.60	3.94	1.23	0.50	4.06	3.34	6.44
15	2	30	0.83	2.17	1.09	4.55	3.77	0.87	4.18
15	2	70	4.38	6.87	4.09	6.22	5.76	6.73	6.02
15	2	110	4.09	5.10	1.92	4.82	5.93	6.16	7.85
15	4	30	9.42	2.06	6.36	2.18	0.83	4.56	6.53
15	4	70	6.12	7.22	0.43	4.24	7.66	5.97	3.96
15	4	110	9.28	2.50	2.96	11.61	9.34	5.02	1.92
50	0	30	3.27	2.59	2.12	1.00	2.29	1.12	1.48
50	0	70	5.76	7.12	2.05	1.00	1.50	5.12	3.28
50	0	110	2.74	1.80	3.03	8.53	5.31	2.12	0.71
50	2	30	2.45	7.98	4.32	12.34	5.54	2.92	2.77
50	2	70	1.64	4.09	4.56	10.52	9.34	9.23	5.45
50	2	110	4.15	5.07	6.71	3.70	0.50	5.02	2.69
50	4	30	2.55	2.18	0.43	2.59	2.87	4.15	7.46
50	4	70	2.28	9.57	11.29	9.34	10.16	2.17	10.42
50	4	110	2.87	5.18	5.67	15.37	3.54	2.86	4.55

Contd...

APPENDIX 3.XIX (CONTD.)

RI (sec)	P.A.	T (deg.)	DISTANCE 1	2	3	4	5	6	7
0	0	30	5.97	3.77	2.95	1.58	18.26	9.01	7.05
0	0	70	7.97	2.49	5.63	8.08	13.79	2.17	11.52
0	0	110	4.50	6.83	5.12	7.56	8.58	8.19	9.23
0	2	30	2.77	5.34	4.12	6.10	9.31	11.06	12.60
0	2	70	8.41	6.26	9.36	6.58	13.81	11.45	19.16
0	2	110	1.48	4.58	5.76	5.61	12.62	2.96	9.12
0	4	30	3.32	1.22	3.67	4.82	24.18	5.34	28.79
0	4	70	8.09	5.94	9.01	6.75	11.76	13.49	23.86
0	4	110	10.30	3.56	3.91	3.91	10.42	4.44	4.39
15	0	30	5.52	2.69	5.36	7.02	17.27	8.46	10.64
15	0	70	14.28	9.14	2.95	14.81	14.15	14.64	15.58
15	0	110	3.20	5.12	4.56	3.96	12.08	3.64	6.87
15	2	30	6.80	1.87	4.95	9.26	16.42	11.08	11.92
15	2	70	13.95	5.05	8.26	15.92	19.75	17.65	7.46
15	2	110	1.92	3.70	3.74	5.36	5.67	9.68	9.36
15	4	30	8.26	7.60	5.26	1.92	13.77	13.75	18.32
15	4	70	13.97	1.22	10.78	13.20	16.87	13.05	12.34
15	4	110	3.56	2.95	6.46	11.39	8.93	12.08	12.97
50	0	30	7.84	3.50	14.72	19.76	5.76	11.76	12.66
50	0	70	24.76	19.62	16.41	9.10	19.56	5.83	26.52
50	0	110	3.89	11.01	2.18	4.36	15.61	9.23	9.07
50	2	30	13.25	5.80	5.07	8.93	15.41	17.27	19.92
50	2	70	19.84	17.94	18.06	18.42	8.10	8.84	24.40
50	2	110	2.06	7.15	3.54	8.54	9.68	9.76	6.65
50	4	30	34.73	10.82	5.76	21.41	13.95	10.21	5.10
50	4	70	23.41	16.10	2.28	21.53	2.12	21.96	5.40
50	4	110	6.18	9.63	5.41	5.85	13.44	15.82	6.20

3.69

APPENDIX 3,XX

CE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.5

SIGHTED

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg)	1	2	3	4	5	6	7
0	0	30	0.75	0.25	1.00	0.00	0.50	1.50	2.50
0	0	70	0.00	0.50	-0.50	-0.25	-1.50	0.75	1.75
0	0	110	-4.25	-2.75	-4.75	-0.50	-1.75	-2.75	-10.00
0	2	30	5.50	6.25	4.50	4.75	5.75	4.00	8.28
0	2	70	-4.25	-5.50	-0.25	2.50	-8.00	-4.50	2.25
0	2	110	-10.00	-5.25	-8.50	-11.25	-6.00	-7.25	-12.00
0	4	30	10.25	12.50	9.75	9.00	5.75	13.75	10.00
0	4	70	-12.75	-7.75	-6.00	-6.00	-7.25	-14.25	0.75
0	4	110	-16.75	-10.00	-19.00	-17.00	-18.50	-17.50	-11.75
15	0	30	0.50	0.00	0.50	1.00	0.25	0.50	1.00
15	0	70	-0.75	-0.25	-1.75	0.00	-2.00	-0.25	-4.50
15	0	110	-2.50	-1.75	-4.50	-4.25	-2.25	-1.00	-8.25
15	2	30	6.00	8.25	4.75	5.25	5.00	6.75	13.75
15	2	70	-8.25	-9.75	-7.75	4.00	-9.00	11.25	-4.25
15	2	110	-10.00	3.00	-10.75	-10.50	-11.50	-11.50	-17.25
15	4	30	10.25	-2.00	9.25	8.75	11.00	14.75	13.75
15	4	70	-12.25	-5.75	-10.75	-7.00	-13.50	-5.50	-6.00
15	4	110	-16.75	-5.75	-16.00	-16.25	-18.50	-19.25	-18.00
50	0	30	0.00	2.00	0.75	0.25	0.50	1.50	2.50
50	0	70	-1.75	2.00	-1.75	-2.25	-3.00	-2.75	-0.75
50	0	110	-4.25	-2.00	-4.50	-4.75	-4.00	-4.00	-6.50
50	2	30	6.25	8.00	4.50	5.25	5.75	4.75	12.00
50	2	70	-8.00	-8.50	-4.50	-8.25	-4.25	0.00	2.00
50	2	110	-12.25	-12.00	-11.00	-6.00	-13.25	-10.75	-19.50
50	4	30	10.00	8.25	3.50	10.25	10.50	7.25	18.25
50	4	70	-6.50	7.50	-11.75	-12.50	-6.75	-6.25	-21.00
50	4	110	-16.75	-13.75	-17.00	-16.75	-18.75	-19.00	-21.75

3.70

APPENDIX 3.XX (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg)	1	2	3	4	5	6	7
0	0	30	4.50	8.00	5.00	4.25	5.00	2.25	4.50
0	0	70	0.25	1.75	4.50	3.25	5.00	4.00	-0.50
0	0	110	-13.25	-14.50	12.00	-11.50	12.25	-14.50	-14.00
0	2	30	0.25	6.25	3.50	3.00	4.00	5.50	5.00
0	2	70	-2.50	10.75	-5.00	5.25	9.50	-1.25	-0.25
0	2	110	-12.00	-13.75	-11.75	-14.00	-14.25	-13.00	-14.25
0	4	30	-2.00	1.75	5.25	5.00	5.25	5.50	4.75
0	4	70	-6.50	0.25	-8.75	1.25	0.50	-2.00	-5.00
0	4	110	-12.50	-13.75	-13.75	-14.00	-14.00	-13.75	-13.75
15	0	30	2.50	18.50	9.75	8.75	10.75	9.25	10.25
15	0	70	-13.50	-5.75	6.00	-8.00	-15.75	-7.50	13.25
15	0	110	-19.00	-22.00	-19.50	-20.25	-19.25	-21.25	-20.25
15	2	30	4.25	9.25	8.50	6.50	7.75	9.50	10.00
15	2	70	-13.25	0.75	-6.75	-14.00	8.75	-3.50	-0.75
15	2	110	-18.00	-20.50	-17.50	-19.50	-19.50	-20.25	-20.00
15	4	30	6.25	21.75	9.00	8.75	10.25	9.00	9.00
15	4	70	9.75	0.00	-7.25	-6.50	7.00	5.75	-0.75
15	4	110	-20.75	-13.25	-19.25	-20.00	-20.00	-21.00	-19.75
50	0	30	13.50	18.00	15.25	14.25	17.50	6.50	13.75
50	0	70	-31.00	11.50	-20.50	-20.25	-12.75	11.25	-2.00
50	0	110	-33.75	-26.00	-23.25	-26.50	-25.25	-32.00	-25.00
50	2	30	-11.25	11.25	15.00	14.00	16.50	15.50	14.75
50	2	70	-15.50	8.00	-20.50	-20.75	12.25	-0.50	-7.75
50	2	110	-33.00	-29.50	-27.25	-28.00	-27.25	-32.75	-31.50
50	4	30	-26.50	25.25	14.75	14.75	17.25	14.00	13.50
50	4	70	-30.75	26.25	-22.50	-19.25	12.00	14.00	-20.50
50	4	110	-32.25	-37.00	-29.00	-27.75	-28.00	-30.00	-29.75

Contd....

3.71

APPENDIX 3.XX (CONTD.)

BLIND

LOCATION

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg)	1	2	3	4	5	6	7
0	0	30	1.75	1.75	0.75	3.75	1.25	1.25	0.25
0	0	70	-2.25	-1.00	-1.00	1.50	1.50	0.00	0.00
0	0	110	-1.25	0.00	-1.00	-2.25	-1.25	-1.00	-0.50
0	2	30	1.25	2.25	2.75	11.75	7.75	5.00	-1.75
0	2	70	0.50	4.00	-2.00	3.50	4.00	-3.75	2.75
0	2	110	1.25	-9.50	-5.50	-8.00	2.50	-5.50	-3.25
0	4	30	3.25	6.00	0.75	4.25	2.00	4.75	1.25
0	4	70	4.00	5.50	-3.00	10.00	8.00	1.00	-6.00
0	4	110	-1.75	-10.75	-10.50	-11.25	-4.25	11.00	-9.25
15	0	30	1.50	3.25	3.50	2.75	3.25	2.00	-0.25
15	0	70	-4.50	5.50	-2.25	2.25	4.50	-1.00	-3.00
15	0	110	-6.50	-3.00	-6.00	-5.50	1.00	-0.25	-1.00
15	2	30	3.75	6.75	2.75	12.75	12.75	5.50	3.00
15	2	70	-6.25	-4.75	-1.75	2.50	3.75	-2.50	5.25
15	2	110	-13.50	-12.00	-10.25	-11.50	-4.25	-10.00	-7.25
15	4	30	11.25	11.50	2.00	9.50	7.25	10.50	-2.25
15	4	70	-3.00	3.25	-5.75	12.00	6.75	1.25	4.75
15	4	110	-8.00	-15.50	-9.50	-6.50	-1.25	-7.50	-11.25
50	0	30	5.25	3.75	4.00	6.00	5.50	4.50	0.25
50	0	70	-3.75	2.25	-3.75	7.00	4.50	-2.50	-3.50
50	0	110	-10.00	-5.50	-5.75	-0.25	0.25	-2.00	-5.00
50	2	30	7.00	8.75	6.75	11.25	15.50	11.00	2.25
50	2	70	-11.25	-10.50	-3.50	5.50	5.50	-7.50	-12.75
50	2	110	-15.75	-23.75	-6.00	-12.75	-7.50	-16.50	-12.50
50	4	30	10.00	10.50	8.75	19.25	12.50	10.25	0.75
50	4	70	-8.25	1.00	-1.00	5.75	4.50	-13.25	-5.00
50	4	110	-10.50	-15.50	14.25	-13.50	-10.00	-17.25	-14.75

Contd..

APPENDIX 3.XX (CONTD.)

DISTANCE

CONDITIONS			SUBJECTS						
RI (sec)	P.A.	T (deg)	1	2	3	4	5	6	7
0	0	30	8.75	6.50	8.75	12.00	6.00	5.75	3.75
0	0	70	5.00	7.75	2.25	2.50	-2.75	13.75	-4.75
0	0	110	20.50	-13.25	-12.25	-19.25	-36.25	-18.00	-21.50
0	2	30	13.75	12.00	9.00	1.50	13.75	4.50	23.25
0	2	70	-4.50	-0.75	2.75	-9.50	-8.75	1.50	5.50
0	2	110	-20.25	-19.00	-22.25	-22.00	-31.75	-34.50	-27.50
0	4	30	13.00	6.00	14.00	10.25	20.75	9.00	10.25
0	4	70	5.00	-0.50	2.25	3.00	-2.75	-2.00	-4.25
0	4	110	-12.00	-19.25	-22.50	-24.50	-38.00	-20.75	-18.50
15	0	30	14.00	16.50	16.75	4.50	22.50	14.00	22.25
15	0	70	2.00	1.00	11.25	-1.25	-3.50	3.75	11.50
15	0	110	-24.50	-21.25	-22.50	-21.25	-4.00	-20.75	-26.50
15	2	30	27.75	13.00	10.00	5.25	0.00	7.25	35.00
15	2	70	2.75	-15.00	-3.75	-13.00	-7.00	-8.00	16.75
15	2	110	-26.25	-25.25	-30.00	-36.50	-47.75	-33.25	-29.75
15	4	30	21.75	21.25	9.75	16.25	33.00	10.75	20.75
15	4	70	0.50	16.00	-3.50	-8.50	-1.00	-11.50	25.75
15	4	110	-25.25	-23.25	-25.75	-28.75	-49.25	-33.75	-20.50
50	0	30	39.00	31.50	6.25	6.00	25.25	5.75	19.50
50	0	70	3.50	-6.50	13.25	-5.50	-12.00	17.00	-11.50
50	0	110	-37.75	-22.50	-28.50	-41.00	36.75	-22.50	-37.50
50	2	30	33.25	25.25	20.75	19.75	30.00	7.75	48.75
50	2	70	9.00	-10.75	-3.25	1.75	-19.75	-23.75	15.25
50	2	110	-33.50	-31.75	-40.00	-47.00	-49.25	-51.50	28.50
50	4	30	21.50	25.00	27.25	-4.25	35.75	31.50	44.00
50	4	70	11.25	-2.75	17.25	-12.00	-23.00	11.50	32.25
50	4	110	-37.50	-34.50	-4[illegible].50	-44.75	-55.75	-45.50	-34.00

3.73

APPENDIX 3.XXI

AE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractor	Retention intervals	Subject	Targets (in cm.)		
			10	20	30
Rest	20 sec	1	0.20	0.90	1.83
		2	0.43	0.63	1.13
		3	0.30	0.58	1.05
		4	0.15	0.93	1.25
		5	1.28	1.50	1.65
		6	0.38	0.85	0.68
		7	0.40	0.63	1.83
		8	1.18	1.50	1.53
		9	0.30	0.88	1.63
		10	0.65	0.83	1.85
		11	0.98	1.30	1.80
		12	0.43	1.00	0.93
	90 sec	1	0.25	0.55	1.10
		2	0.68	0.60	2.30
		3	0.58	0.60	2.30
		4	1.13	0.58	1.25
		5	1.23	0.93	2.08
		6	0.73	1.18	2.23
		7	0.25	0.48	1.38
		8	1.18	2.68	2.43
		9	0.78	1.10	1.35
		10	0.90	1.25	2.38
		11	0.45	1.25	1.65
		12	0.45	1.53	1.35

Contd.....

3.74

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subject	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.20	1.55	2.85
		2	1.93	2.33	2.58
		3	1.75	2.20	3.63
		4	0.78	1.43	1.70
		5	1.08	1.98	2.45
		6	2.48	2.48	2.48
		7	2.55	2.35	3.70
		8	0.83	2.33	2.50
		9	1.90	2.30	3.23
		10	2.35	2.63	2.88
		11	2.30	2.40	2.75
		12	1.55	1.53	2.70
	90 sec	1	2.65	2.20	4.18
		2	3.10	3.05	4.15
		3	3.45	3.70	4.60
		4	2.35	2.48	3.80
		5	1.13	1.73	3.00
		6	2.05	3.13	3.70
		7	2.90	3.48	4.68
		8	2.28	2.05	3.03
		9	1.80	3.10	3.50
		10	2.78	3.65	3.68
		11	2.60	1.80	3.53
		12	2.10	2.75	3.08

Contd....

3.75

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subject	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.40	1.15	1.85
		2	1.53	1.88	2.59
		3	1.30	1.83	3.73
		4	0.98	0.88	1.86
		5	1.50	1.93	3.98
		6	2.08	1.35	3.45
		7	1.55	2.15	3.85
		8	1.43	2.13	3.00
		9	0.85	1.68	3.35
		10	1.63	1.83	3.90
		11	1.53	1.65	3.18
		12	0.90	1.10	3.38
	90 sec	1	1.95	1.10	3.38
		2	2.75	3.40	3.65
		3	2.45	2.63	3.93
		4	1.73	2.23	3.45
		5	1.63	3.53	3.35
		6	2.35	2.73	3.55
		7	2.90	3.30	3.53
		8	1.75	2.68	3.25
		9	2.03	2.73	3.28
		10	2.68	2.50	4.48
		11	1.73	2.10	3.98
		12	1.38	3.08	2.93

Contd...

3.76

APPENDIX 3.XXI (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.28	3.50	6.25
		2	2.45	4.35	6.18
		3	3.28	4.58	6.38
		4	2.73	3.63	5.20
		5	2.60	5.15	6.15
		6	2.28	3.98	3.23
		7	3.45	3.88	3.13
		8	2.65	4.33	4.33
		9	2.30	3.23	4.65
		10	3.13	3.45	4.75
		11	3.38	3.53	7.13
		12	2.73	3.70	4.30
	90 sec	1	5.18	5.05	8.13
		2	4.25	5.60	8.45
		3	6.05	6.03	9.00
		4	3.48	3.88	7.75
		5	4.35	4.55	7.65
		6	3.40	5.68	8.83
		7	4.13	5.15	7.60
		8	3.60	4.43	7.65
		9	4.30	6.08	7.63
		10	4.88	5.25	7.48
		11	5.38	6.13	9.08
		12	4.23	5.48	8.78

Contd...

DISTANCE

Detector	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.26	3.50	6.25
		2	2.45	4.33	5.78
		3	3.28	4.58	6.38
		4	2.73	3.63	5.20
		5	2.40	3.75	6.13
		6	2.28	3.98	7.27
		7	3.45	3.88	3.13
		8	2.65	4.33	4.23
		9	2.30	3.23	4.68
		10	3.13	3.45	4.75
		11	3.38	3.53	7.13
		12	2.73	3.70	4.30
	90 sec	1	5.18	5.05	8.13
		2	4.25	5.60	8.43
		3	6.03	6.03	9.00
		4	3.48	3.98	7.73
		5	4.35	4.55	7.85
		6	3.40	5.68	8.23
		7	4.13	5.13	7.60
		8	3.60	4.43	7.65
		9	4.30	6.08	7.63
		10	4.88	5.63	7.48
		11	5.38	6.13	9.08
		12	4.23	5.43	8.78

Contd...

3.77

APPENDIX 3.XXI (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	2.28	3.78	6.28
		2	2.83	3.35	5.35
		3	3.95	3.68	6.23
		4	2.73	3.38	4.88
		5	2.85	3.73	5.00
		6	2.20	4.53	7.55
		7	3.73	4.03	6.98
		8	2.15	4.85	5.40
		9	2.08	4.15	5.40
		10	2.55	3.05	6.33
		11	3.42	3.15	5.83
		12	2.25	3.40	6.55
	90 sec	1	3.93	4.75	8.03
		2	3.55	6.05	7.95
		3	6.15	5.25	8.58
		4	2.23	5.83	6.15
		5	3.50	4.53	4.65
		6	2.58	3.45	8.48
		7	5.10	4.80	8.85
		8	1.70	5.48	9.03
		9	3.58	6.45	8.73
		10	4.13	3.88	7.58
		11	4.35	4.93	8.55
		12	4.05	5.08	7.58

Contd...

3.78

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.55	3.08	5.58
		2	2.15	2.48	5.20
		3	3.78	4.88	5.90
		4	2.30	6.28	4.88
		5	2.20	4.15	5.05
		6	2.70	3.63	5.43
		7	3.25	3.83	6.98
		8	1.93	2.98	6.58
		9	2.48	3.75	4.93
		10	2.80	3.38	3.93
		11	2.88	3.65	5.85
		12	2.75	3.90	6.18
	90 sec	1	4.80	4.60	7.25
		2	3.53	4.58	7.70
		3	6.30	6.35	7.13
		4	4.55	3.50	7.85
		5	2.00	4.23	8.05
		6	2.85	3.58	7.45
		7	5.68	4.60	9.38
		8	3.43	3.43	5.43
		9	3.73	5.03	6.75
		10	5.03	4.75	7.18
		11	4.38	4.80	8.88
		12	4.85	4.88	8.45

Contd....

3.79

APPENDIX 3.XXI (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	targets (in cm.)		
			10	20	30
Control	20 sec	1	0.28	0.30	2.30
		2	0.43	0.68	1.88
		3	0.33	0.40	1.55
		4	0.45	0.60	1.20
		5	0.28	0.85	1.43
		6	0.50	0.43	0.88
		7	0.40	0.83	2.45
		8	0.20	0.45	3.30
		9	0.53	0.55	1.68
		10	0.48	0.80	1.58
		11	0.38	0.50	1.23
		12	0.58	0.48	2.38
	90 sec	1	0.30	0.40	2.68
		2	0.33	0.70	2.00
		3	0.33	0.85	1.50
		4	0.53	1.00	1.93
		5	0.78	0.63	1.73
		6	0.43	0.80	2.05
		7	0.58	0.78	1.15
		8	0.43	0.45	1.50
		9	0.40	0.40	1.60
		10	0.40	0.40	1.83
		11	0.38	0.75	0.80
		12	0.40	0.48	1.78

Contd.....

3.80

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.30	2.28	3.00
		2	1.70	2.03	2.63
		3	2.15	2.20	3.00
		4	0.95	1.90	1.65
		5	4.13	2.18	2.15
		6	1.28	2.15	2.10
		7	1.03	1.50	2.30
		8	1.33	1.73	3.75
		9	1.15	2.70	2.95
		10	2.33	2.65	2.05
		11	2.10	1.75	1.63
		12	2.00	2.60	1.90
	90 sec	1	2.25	1.13	2.50
		2	4.00	1.83	3.45
		3	2.60	3.88	4.80
		4	3.50	2.85	2.78
		5	2.03	2.43	3.08
		6	3.30	3.55	3.93
		7	2.58	3.08	2.58
		8	3.80	3.85	4.20
		9	4.03	4.80	4.05
		10	4.00	2.78	2.73
		11	2.68	2.23	3.08
		12	3.18	4.68	4.20

Contd...

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.30	2.28	3.00
		2	1.70	2.03	2.69
		3	2.15	2.80	3.40
		4	0.95	1.90	1.65
		5	4.13	2.18	2.15
		6	1.28	2.15	2.70
		7	1.03	1.30	2.30
		8	1.23	1.23	3.75
		9	1.15	2.70	2.95
		10	2.33	2.65	2.05
		11	2.10	1.75	1.60
		12	2.00	2.60	1.90
	90 sec	1	2.25	1.13	2.50
		2	4.00	1.83	3.45
		3	2.60	3.28	4.80
		4	3.50	2.85	2.78
		5	2.03	2.43	3.08
		6	3.30	3.55	3.93
		7	2.58	3.08	2.58
		8	3.80	3.85	4.20
		9	4.03	4.80	4.05
		10	4.00	2.78	2.72
		11	2.68	2.23	3.08
		12	3.18	4.08	4.20

3.81

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.23	2.60	1.78
		2	1.68	1.75	4.25
		3	1.28	2.20	3.55
		4	1.88	1.38	2.05
		5	1.33	1.83	3.53
		6	1.43	1.58	3.70
		7	1.75	2.25	3.33
		8	2.83	4.18	3.48
		9	2.38	4.03	4.13
		10	2.75	3.38	3.53
		11	1.60	1.88	3.38
		12	2.15	2.20	2.23
	90 sec	1	3.85	2.20	2.23
		2	2.65	4.65	5.45
		3	3.30	3.68	5.18
		4	2.48	3.33	5.00
		5	2.38	3.88	4.13
		6	1.13	4.33	4.70
		7	3.20	2.98	4.43
		8	2.70	4.70	4.73
		9	2.40	3.80	3.05
		10	3.90	2.78	3.12
		11	1.50	3.15	4.63
		12	2.73	3.98	4.13

Contd.....

3.82

APPENDIX 3.XXI (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	3.23	5.30	8.78
		2	2.03	5.80	7.00
		3	2.40	8.00	12.05
		4	8.63	5.40	5.75
		5	5.53	8.93	6.93
		6	3.63	3.18	7.83
		7	4.08	3.60	7.33
		8	4.08	2.93	8.73
		9	2.53	4.20	7.43
		10	2.25	4.60	8.25
		11	6.13	3.83	5.93
		12	1.03	4.13	7.35
	90 sec	1	5.50	7.33	12.30
		2	6.00	9.55	13.95
		3	8.50	8.43	13.80
		4	11.33	8.50	9.83
		5	15.73	10.50	6.70
		6	4.88	6.55	11.88
		7	5.85	6.85	11.05
		8	5.33	6.10	7.23
		9	5.90	11.00	11.88
		10	6.70	6.08	14.20
		11	7.10	10.28	13.78
		12	5.28	5.85	14.23

Contd....

Distance	Rotation interval	Subjects	Targets (in cm.)	
			10	20
Control	20 sec	1	3.29	5.30
		2	2.03	5.80
		3	2.40	6.00
		4	8.03	5.40
		5	5.39	6.93
		6	3.63	3.15
		7	4.08	3.80
		8	4.08	5.93
		9	2.39	4.20
		10	2.65	4.50
		11	6.73	3.93
		12	1.09	4.13
	30 sec	1	5.50	4.33
		2	6.10	5.55
		3	8.50	5.13
		4	11.23	8.50
		5	15.73	10.30
		6	4.08	6.53
		7	5.85	6.85
		8	5.39	6.15
		9	5.00	11.00
		10	6.70	6.08
		11	7.10	10.28
		12	5.28	5.68

Contd....

3.83

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	3.15	3.25	9.30
		2	3.50	5.75	6.18
		3	2.18	6.58	12.05
		4	5.08	5.63	5.63
		5	9.10	8.58	4.68
		6	4.00	3.45	5.35
		7	3.13	3.58	6.85
		8	2.55	3.38	7.78
		9	3.63	5.08	6.78
		10	3.68	4.88	6.23
		11	6.05	3.45	8.00
		12	2.95	3.13	9.28
	90 sec	1	4.15	6.65	2.35
		2	8.03	11.58	2.13
		3	8.08	7.73	1.58
		4	7.98	16.08	8.13
		5	7.33	8.60	10.70
		6	13.60	6.95	4.70
		7	4.28	10.68	3.60
		8	6.38	10.40	4.63
		9	4.38	10.25	2.68
		10	10.15	8.83	0.70
		11	8.75	12.65	4.33
		12	7.58	13.55	1.68

Contd.....

3.84

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	6.13	6.48	7.45
		2	6.80	8.45	3.70
		3	8.15	12.13	6.08
		4	10.30	4.68	8.18
		5	11.78	4.88	15.43
		6	4.25	6.75	5.80
		7	4.38	7.03	3.98
		8	3.55	8.13	6.03
		9	3.23	5.40	3.90
		10	3.43	7.53	3.50
		11	2.65	6.20	8.13
		12	3.70	7.78	3.85
	90 sec	1	7.45	6.83	10.50
		2	3.70	4.90	9.33
		3	6.08	4.73	15.85
		4	8.18	10.80	8.70
		5	15.43	13.18	6.88
		6	5.80	5.70	6.73
		7	3.98	4.30	9.78
		8	6.03	4.65	14.40
		9	3.90	4.23	7.33
		10	3.50	8.20	13.20
		11	8.13	5.70	6.05
		12	3.85	6.25	14.85

Dispersion	Repetition intervals	Subjects	Targets (in sec.)		
			10	20	30
Movement	20 sec	1	6.13	6.42	7.45
		2	6.80	8.45	3.70
		3	8.15	12.13	6.02
		4	10.30	4.68	5.18
		5	11.78	4.81	15.43
		6	4.25	5.75	5.80
		7	4.30	7.10	3.98
		8	3.55	6.13	6.13
		9	3.83	5.40	3.70
		10	3.43	7.53	3.50
		11	2.65	6.20	5.13
		12	3.70	7.78	3.85
	90 sec	1	7.45	6.89	10.50
		2	3.70	4.90	3.30
		3	6.08	4.73	13.85
		4	8.18	10.80	6.70
		5	15.43	13.18	6.98
		6	5.80	5.70	6.72
		7	3.98	4.30	3.78
		8	6.03	4.65	14.40
		9	3.90	4.83	3.33
		10	3.30	8.80	13.80
		11	8.13	5.70	6.98
		12	3.85	6.25	14.85

3.85

APPENDIX 3.XXII

VE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractor	Retention interval	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.22	0.90	0.91
		2	0.46	0.67	1.06
		3	0.36	0.62	0.63
		4	0.16	0.58	1.52
		5	1.20	0.56	1.66
		6	0.49	0.39	0.88
		7	0.39	0.29	1.39
		8	0.51	1.65	1.49
		9	0.33	1.20	1.22
		10	0.21	0.92	1.38
		11	1.07	1.43	1.95
		12	0.48	1.19	1.79
	90 sec	1	0.27	0.56	1.26
		2	0.22	0.73	0.25
		3	0.04	0.64	0.48
		4	1.49	0.39	0.99
		5	1.37	0.94	1.60
		6	0.89	1.23	1.89
		7	0.22	0.48	1.12
		8	0.72	1.82	1.08
		9	0.84	1.18	1.02
		10	0.58	1.03	2.44
		11	0.57	1.39	1.63
		12	0.40	1.52	1.47

Contd....

3.86

APPENDIX 3.XXI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.29	1.28	2.48
		2	0.43	2.36	0.63
		3	0.52	2.21	0.58
		4	0.84	0.23	0.65
		5	1.14	1.98	2.07
		6	0.25	2.51	0.69
		7	0.91	2.40	0.41
		8	0.39	0.25	0.87
		9	1.73	1.88	3.26
		10	0.47	2.70	2.53
		11	1.90	1.89	2.87
		12	0.80	1.50	2.41
	90 sec	1	0.21	1.97	3.63
		2	0.71	3.07	0.52
		3	0.38	0.46	0.60
		4	0.17	2.50	1.44
		5	1.33	1.43	3.35
		6	2.45	0.46	3.83
		7	0.96	3.06	0.60
		8	2.35	1.01	2.58
		9	1.77	2.53	3.61
		10	0.71	3.17	3.02
		11	2.67	1.69	3.55
		12	1.63	1.06	0.58

Contd.....

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.43	1.16	1.86
		2	0.26	1.78	0.58
		3	0.37	0.41	0.28
		4	1.39	0.02	1.85
		5	1.51	1.46	3.75
		6	1.99	1.92	3.05
		7	0.41	1.87	0.65
		8	1.55	0.77	2.17
		9	0.75	0.66	3.40
		10	0.25	2.19	3.49
		11	1.04	1.60	3.03
		12	0.88	1.06	1.19
	90 sec	1	1.27	2.53	2.83
		2	0.38	2.59	0.41
		3	1.51	2.72	0.53
		4	1.19	1.74	0.60
		5	1.34	3.61	2.95
		6	2.26	2.44	3.36
		7	0.72	0.61	3.52
		8	0.56	2.79	3.26
		9	1.41	2.81	3.13
		10	0.55	1.05	3.58
		11	0.82	2.24	3.80
		12	1.04	1.18	2.93

Contd....

APPENDIX 3.XXII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.07	3.51	1.48
		2	0.48	4.39	2.00
		3	0.55	3.81	1.58
		4	1.04	3.67	5.50
		5	0.89	0.55	2.24
		6	2.15	0.53	0.94
		7	0.96	3.12	2.82
		8	2.27	4.35	0.61
		9	2.00	2.74	3.51
		10	0.82	2.88	1.59
		11	0.43	3.34	1.27
		12	0.28	0.67	0.54
	90 sec	1	1.02	5.06	1.39
		2	3.33	4.55	1.33
		3	0.94	0.89	1.80
		4	1.65	4.05	1.57
		5	3.90	5.39	5.87
		6	3.57	4.78	1.13
		7	4.15	5.15	1.64
		8	0.57	4.53	5.58
		9	1.37	6.04	1.29
		10	0.78	4.60	0.53
		11	0.72	5.23	0.75
		12	1.15	0.97	1.59

Contd..

APPENDIX 3.XXII (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	0.44	0.57	0.53
		2	2.39	3.02	0.73
		3	0.69	0.87	0.27
		4	2.57	3.10	2.12
		5	3.12	3.82	0.96
		6	1.88	4.62	6.83
		7	1.07	3.62	4.99
		8	2.16	4.07	1.31
		9	1.61	3.63	6.87
		10	1.97	3.13	1.47
		11	0.63	3.17	0.93
		12	1.91	3.44	1.28
	90 sec	1	3.18	4.01	0.38
		2	0.52	4.26	0.66
		3	0.63	5.30	7.20
		4	2.29	2.71	6.80
		5	2.51	3.96	4.85
		6	2.28	3.48	1.05
		7	4.33	4.13	0.61
		8	1.58	5.53	7.93
		9	3.04	1.56	1.17
		10	0.13	4.29	0.70
		11	0.29	4.34	1.63
		12	4.25	0.71	0.85

Contd....

3.90

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.43	3.08	0.70
		2	0.38	2.17	1.00
		3	0.87	5.00	0.99
		4	2.25	5.88	4.90
		5	0.45	3.13	1.31
		6	0.35	3.14	5.33
		7	0.32	3.72	1.83
		8	0.48	3.07	5.50
		9	1.83	3.81	0.77
		10	0.59	2.97	0.55
		11	2.43	3.67	0.68
		12	2.15	4.08	1.32
	90 sec	1	0.79	4.15	1.03
		2	0.61	3.90	1.14
		3	1.06	0.72	5.24
		4	4.72	0.92	6.26
		5	2.05	1.68	0.84
		6	2.97	0.40	7.47
		7	0.70	3.80	0.81
		8	1.08	3.12	0.97
		9	0.72	5.04	0.83
		10	0.75	4.49	0.78
		11	0.36	3.91	1.95
		12	0.79	4.20	1.32

Contd...

APPENDIX 3.XXII (CONTD.)

Distinction	Retention intervals	Subjects	Targets (in cm.)	
			10 - 20	30
Movement	20 sec	1	0.42	3.08
		2	0.36	2.17
		3	0.07	5.00
		4	2.25	5.08
		5	0.45	3.13
		6	0.35	3.14
		7	0.32	3.12
		8	0.42	3.07
		9	1.03	3.81
		10	0.39	2.97
		11	2.43	3.67
		12	2.15	4.08
	90 sec	1	0.79	4.15
		2	0.61	3.90
		3	1.06	0.72
		4	4.72	0.92
		5	2.05	1.68
		6	2.97	0.40
		7	0.70	3.80
		8	1.00	3.18
		9	0.72	5.04
		10	0.75	4.49
		11	0.36	3.97
		12	0.79	4.20

Contd...

3.91

APPENDIX 3.XXII (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.15	0.23	2.10
		2	0.33	0.55	1.73
		3	0.34	0.56	1.39
		4	0.36	0.43	1.39
		5	0.26	0.76	1.45
		6	0.48	0.22	0.89
		7	0.27	0.87	2.95
		8	0.20	0.50	3.92
		9	0.33	0.41	1.74
		10	0.43	0.49	1.81
		11	0.30	0.35	1.30
		12	0.37	0.38	2.19
	90 sec	1	0.21	0.36	1.26
		2	0.31	0.72	1.97
		3	0.34	0.88	1.57
		4	0.33	0.49	2.03
		5	0.64	0.43	1.11
		6	0.33	0.76	2.08
		7	0.33	0.60	1.60
		8	0.26	0.22	1.57
		9	0.12	0.31	2.07
		10	0.23	0.35	1.17
		11	0.23	0.65	0.85
		12	0.23	0.77	1.61

Contd.....

.92

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	0.37	0.22	1.09
		2	0.54	2.10	2.68
		3	0.16	2.25	3.00
		4	0.27	0.39	1.74
		5	3.34	0.64	2.07
		6	0.49	0.38	2.25
		7	0.49	1.00	2.30
		8	1.15	0.98	3.83
		9	1.17	0.70	3.59
		10	0.24	1.01	1.80
		11	1.47	1.29	0.64
		12	1.66	1.52	1.93
	90 sec	1	1.71	1.93	1.69
		2	1.23	1.92	3.55
		3	2.23	3.70	1.08
		4	0.70	2.27	2.69
		5	1.25	2.18	0.71
		6	2.46	0.61	3.93
		7	0.86	3.51	2.32
		8	1.88	3.17	0.58
		9	0.73	2.09	4.13
		10	0.78	2.00	0.54
		11	0.39	1.82	3.24
		12	0.90	1.23	4.30

Contd.....

88005

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.92	1.19	1.50
		2	1.46	1.49	4.38
		3	1.46	2.35	3.64
		4	0.04	0.42	2.05
		5	1.09	1.99	1.23
		6	1.02	1.80	3.46
		7	0.81	6.21	3.05
		8	0.25	0.62	0.59
		9	1.47	1.08	4.44
		10	1.15	1.45	0.86
		11	0.57	0.67	3.49
		12	0.55	0.86	4.38
	90 sec	1	0.93	0.77	2.27
		2	2.32	1.53	2.43
		3	0.31	3.54	4.42
		4	2.57	2.74	5.24
		5	0.26	1.11	4.21
		6	0.94	2.41	4.07
		7	0.89	1.11	3.54
		8	0.07	1.05	4.81
		9	1.33	1.98	2.63
		10	0.23	0.66	2.90
		11	0.85	0.54	4.67
		12	0.01	0.16	2.78

Contd.....

3.94

APPENDIX 3.XXII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	1.60	5.99	2.71
		2	0.18	2.27	6.64
		3	2.75	1.69	3.52
		4	0.92	2.44	7.55
		5	1.73	3.12	7.27
		6	1.94	1.15	4.35
		7	1.19	3.83	3.14
		8	0.73	3.10	3.40
		9	1.49	2.66	0.82
		10	1.51	5.04	0.71
		11	1.76	3.30	4.47
		12	0.45	3.86	2.53
	90 sec	1	2.57	7.71	4.46
		2	0.70	9.92	3.02
		3	0.36	1.93	3.14
		4	2.44	2.81	8.18
		5	2.49	2.98	3.04
		6	2.11	2.32	4.53
		7	3.49	2.80	3.24
		8	1.75	6.16	5.73
		9	2.40	3.10	3.78
		10	3.61	3.17	3.74
		11	1.27	10.09	3.24
		12	2.02	2.65	3.88

contd.

3.95

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	3.18	3.69	2.32
		2	2.07	5.96	2.49
		3	1.84	1.11	0.98
		4	1.99	2.20	2.75
		5	4.38	3.39	1.32
		6	0.70	1.81	2.17
		7	1.49	2.85	2.38
		8	1.36	3.75	7.64
		9	3.18	4.66	0.45
		10	3.51	4.13	5.13
		11	2.91	3.66	3.79
		12	3.52	1.14	2.53
	90 sec	1	4.43	8.03	1.82
		2	0.61	6.95	8.49
		3	2.57	0.64	2.05
		4	2.27	2.10	7.56
		5	1.06	3.47	8.08
		6	4.00	1.33	10.79
		7	1.51	6.84	1.38
		8	3.61	4.71	7.78
		9	2.16	10.12	1.01
		10	1.78	4.54	4.29
		11	1.23	8.30	12.85
		12	5.61	6.98	1.39

Contd....

APPENDIX 3.XXII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.30	4.07	5.32
		2	0.80	7.21	2.68
		3	1.58	4.04	1.94
		4	0.79	11.73	4.38
		5	2.66	0.91	1.56
		6	2.12	3.02	2.20
		7	3.12	4.21	1.36
		8	8.65	3.90	2.01
		9	1.68	3.24	0.73
		10	0.61	2.88	0.89
		11	1.65	3.02	2.23
		12	0.54	0.91	1.27
	90 sec	1	3.00	5.65	4.04
		2	1.01	6.13	4.31
		3	6.66	0.53	1.39
		4	5.72	8.92	8.69
		5	0.94	11.84	7.39
		6	1.67	0.87	6.82
		7	1.19	4.08	2.78
		8	3.60	4.66	12.52
		9	1.78	4.49	3.32
		10	3.70	7.75	3.49
		11	0.91	6.78	5.03
		12	3.20	4.92	2.67

3.97

APPENDIX 3.XXIII

CE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distructor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.10	-0.50	-1.83
		2	0.13	0.08	-0.88
		3	0.05	-0.08	-1.05
		4	-0.15	-0.93	-0.05
		5	0.83	0.65	-0.35
		6	0.38	-3.85	0.53
		7	0.30	0.63	-1.33
		8	1.18	0.45	0.73
		9	-0.10	-0.03	1.18
		10	0.65	0.08	-1.35
		11	0.33	0.65	0.65
		12	0.18	0.05	0.08
	90 sec	1	0.00	-0.10	-0.45
		2	0.68	-0.05	-0.58
		3	0.58	-0.10	-2.30
		4	0.23	-0.58	0.80
		5	-0.18	0.48	-1.58
		6	-0.13	-0.13	-1.18
		7	0.25	0.08	-0.98
		8	-1.18	2.23	-2.43
		9	0.33	0.65	-1.15
		10	0.90	1.25	-0.23
		11	-0.05	0.20	1.65
		12	-0.25	-0.68	-0.35

Contd....

APPENDIX 3.XXIII

CE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.6

Distractor	Retention intervals	Subjects	Targets (in cm.)	
Control	20 sec	1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		
	90 sec	1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		

3.98

APPENDIX 3.XXIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	-0.35	0.95	-1.40
		2	1.93	0.23	-2.58
		3	1.75	-0.10	-3.63
		4	-0.23	1.43	-1.70
		5	0.08	0.38	1.75
		6	2.48	0.43	-2.48
		7	2.55	0.15	-3.70
		8	0.83	2.33	-2.50
		9	1.55	-1.50	-1.03
		10	2.35	1.43	1.43
		11	1.65	2.10	-0.10
		12	1.55	-0.48	-1.25
	90 sec	1	2.65	-1.00	-2.13
		2	3.10	0.25	-4.15
		3	3.45	-3.70	-4.60
		4	2.35	-0.18	-3.80
		5	-0.28	1.33	-0.20
		6	0.60	-3.13	-0.05
		7	2.90	-1.73	-4.68
		8	0.33	-2.05	1.98
		9	1.15	1.90	0.40
		10	2.78	1.90	-2.13
		11	0.10	0.93	- 1.23
		12	1.90	2.75	-3.08

Contd...

3.99

APPENDIX 3.XXIII (CONTD.)

Distructor	Retention intervals	Subjects	Targets (in cm)		
			10	20	30
Movement	20 sec	1	-0.40	0.40	0.30
		2	1.53	-0.68	-2.58
		3	1.30	-1.83	-3.73
		4	0.28	0.18	0.68
		5	0.10	1.33	1.58
		6	-0.78	0.65	1.85
		7	1.55	1.15	-3.85
		8	-0.28	-2.13	-2.50
		9	0.60	-1.68	0.30
		10	1.63	0.68	-1.90
		11	1.33	1.45	1.23
		12	-0.40	0.45	3.38
	90 sec	1	1.80	0.13	-0.38
		2	2.78	2.40	-3.65
		3	2.45	0.03	-3.93
		4	-1.53	-1.58	-3.45
		5	1.03	0.08	-1.60
		6	1.00	-1.48	1.35
		7	2.90	3.30	0.03
		8	1.75	-0.13	0.60
		9	1.63	0.33	1.18
		10	2.68	2.50	2.78
		11	1.73	0.45	1.48
		12	0.98	3.08	-0.68

Contd...

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APPENDIX 3.XXIII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	-1.03	-0.30	-6.25
		2	2.45	0.10	-6.18
		3	3.28	2.58	-6.38
		4	2.73	2.43	-0.75
		5	2.60	5.15	6.15
		6	-0.83	-3.98	-3.23
		7	3.45	2.38	1.63
		8	1.55	0.38	-4.33
		9	1.25	-2.23	-3.35
		10	3.13	-1.95	-4.75
		11	3.38	-1.28	-7.13
		12	-2.73	-3.70	-4.30
	90 sec	1	5.18	-0.70	-8.13
		2	2.75	-3.35	-8.45
		3	6.05	6.03	-9.00
		4	3.48	-1.38	-7.75
		5	2.40	-0.20	-5.15
		6	-0.10	-3.98	-8.83
		7	1.33	-0.20	-7.60
		8	3.60	-0.43	-5.65
		9	4.30	-1.83	-7.63
		10	4.88	2.40	-7.48
		11	5.38	-3.83	-9.08
		12	4.23	-5.48	-8.78

Contd...

APPENDIX 3.XXIII (CONTD.)

DISTANCES

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	-1.03	-0.30	-6.29
		2	2.45	0.10	-6.48
		3	3.28	2.38	-6.38
		4	2.73	2.43	-4.75
		5	2.80	5.75	6.15
		6	-0.83	-3.98	-3.23
		7	3.45	2.38	1.08
		8	1.55	0.38	-4.33
		9	1.25	-2.23	-3.35
		10	3.13	-1.95	-4.78
		11	3.38	-1.28	-7.13
		12	-2.73	-3.70	-4.30
	90 sec	1	5.18	-0.70	-0.13
		2	2.75	-3.35	-8.45
		3	6.05	0.03	-9.00
		4	3.48	-1.38	-7.75
		5	2.40	-0.20	-5.13
		6	-0.10	-3.08	-8.89
		7	1.33	-0.20	-7.00
		8	3.60	-0.13	-5.65
		9	4.30	-1.83	-7.68
		10	4.38	2.40	-7.48
		11	5.38	-3.33	-9.08
		12	4.23	-5.48	-8.78

Contd...

3.101

APPENDIX 3.XXIII(CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm)		
			10	20	30
Counting	20 sec	1	2.28	-3.78	-6.28
		2	1.58	-1.60	-5.35
		3	3.95	3.68	-6.23
		4	1.93	-1.88	-4.88
		5	0.35	-1.38	-5.00
		6	1.25	0.58	-3.45
		7	3.73	-1.93	-5.33
		8	0.50	-2.80	-5.40
		9	1.48	-2.15	-5.40
		10	1.75	0.15	-6.33
		11	3.43	-0.65	-5.83
		12	1.35	0.15	-6.55
	90 sec	1	2.43	-2.75	-8.93
		2	3.55	-0.70	-7.95
		3	6.15	0.25	-4.77
		4	-6.03	-5.83	0.20
		5	2.75	2.28	-1.40
		6	1.33	-1.15	-8.48
		7	3.00	2.55	-8.85
		8	1.10	-1.38	-4.33
		9	2.58	-5.45	-8.73
		10	4.13	0.38	-7.58
		11	4.35	2.53	-8.55
		12	-0.25	-5.08	-7.58

Contd....

APPENDIX 3.XXIII(CONTD.)

Duration	Detention intervals	Subjects	Targets (in cm)	
			10	20
Counting	20 sec.	1	2.28	-3.70
		2	1.58	-1.60
		3	3.95	3.68
		4	1.93	-1.03
		5	0.35	-1.38
		6	1.25	0.38
		7	3.73	-1.33
		8	0.30	-2.80
		9	1.40	-2.15
		10	1.75	0.15
		11	5.43	-0.05
		12	1.25	0.15
	30 sec.	1	2.43	-2.75
		2	3.55	-0.70
		3	6.15	0.25
		4	-0.03	-5.43
		5	2.75	2.28
		6	1.33	-1.15
		7	3.00	2.55
		8	1.10	-1.30
		9	2.38	-2.45
		10	4.13	0.38
		11	4.35	3.33
		12	-0.85	-5.18

Contd....

APPENDIX 3.XXIII (CONTD.)

Distraction	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.55	0.18	-5.58
		2	2.15	1.23	-5.20
		3	3.78	0.13	-5.90
		4	-1.55	2.73	-1.88
		5	2.20	3.30	-5.05
		6	2.70	1.88	-2.58
		7	3.25	-1.23	-6.98
		8	1.93	-1.03	-3.98
		9	1.88	-0.60	-4.93
		10	2.80	-1.63	-3.93
		11	1.58	0.35	-5.85
		12	2.00	-0.90	-6.18
	90 sec	1	4.80	2.10	-7.25
		2	3.53	2.58	-7.70
		3	6.30	6.35	-5.13
		4	2.65	3.50	-5.00
		5	-0.70	4.23	-8.05
		6	0.45	3.58	-1.30
		7	5.68	-2.65	-9.38
		8	3.43	1.78	-5.43
		9	3.73	-0.23	-6.75
		10	5.03	-1.75	-7.18
		11	4.38	-2.90	-8.88
		12	4.85	-2.58	-8.45

Contd.....

Distraction	Retention Interval	Subjects	Targets (in cm.)	
			10	20
Movement	20 sec	1	2.55	0.14
		2	2.15	1.23
		3	3.73	0.13
		4	-1.55	2.73
		5	2.80	3.30
		6	2.70	1.38
		7	3.25	-1.23
		8	1.93	-1.08
		9	11.88	-4.60
		10	2.80	-1.03
		11	1.32	0.35
		12	2.00	-0.90
	30 sec	1	4.80	2.10
		2	3.33	2.33
		3	0.30	0.35
		4	2.65	3.30
		5	-0.70	4.13
		6	0.45	3.13
		7	2.68	-2.93
		8	3.43	1.78
		9	3.73	-0.23
		10	2.03	-1.70
		11	4.34	-2.63
		12	4.85	-2.27

Contd....

APPENDIX 3.XXIII (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.28	0.30	1.80
		2	0.43	0.53	-0.78
		3	0.33	0.00	-0.75
		4	0.45	0.60	0.55
		5	0.28	0.85	-1.08
		6	0.25	0.43	-0.63
		7	0.40	0.28	-0.45
		8	0.20	0.45	-0.80
		9	0.53	0.45	1.48
		10	0.48	0.80	-0.08
		11	0.38	0.50	-0.18
		12	0.58	0.48	1.88
	90 sec	1	0.30	0.25	2.68
		2	0.33	-0.35	0.90
		3	0.33	-0.25	-0.35
		4	0.53	1.00	-0.58
		5	0.78	0.53	-1.53
		6	0.43	0.55	0.05
		7	0.58	0.68	-0.10
		8	0.43	0.45	-1.40
		9	0.40	0.40	-1.15
		10	0.40	0.25	1.73
		11	0.38	0.60	-0.35
		12	0.40	-0.38	1.53

Contd....

3.104

APPENDIX 3.XXIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.30	2.28	3.00
		2	1.70	0.73	-1.28
		3	2.15	0.35	0.55
		4	0.95	1.90	0.55
		5	4.13	2.18	-1.35
		6	1.28	2.15	-0.90
		7	1.03	1.30	-1.00
		8	1.33	1.73	-1.75
		9	0.80	2.70	-1.10
		10	2.33	2.65	1.05
		11	1.75	1.35	-1.63
		12	2.00	2.60	0.35
	90 sec	1	2.20	0.88	2.50
		2	4.00	0.93	0.15
		3	1.40	2.13	-4.80
		4	3.50	1.90	-1.33
		5	1.93	1.58	-3.08
		6	2.70	3.55	0.03
		7	2.58	1.73	-1.38
		8	3.80	2.80	-4.20
		9	4.93	4.80	0.70
		10	4.00	2.78	-2.73
		11	2.68	1.48	0.98
		12	3.18	4.68	0.50

Contd.....

3.105

APPENDIX 3.XXIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.23	2.60	1.23
		2	1.28	1.75	0.65
		3	0.18	-0.53	-1.75
		4	1.88	1.38	-0.85
		5	1.33	1.18	3.53
		6	1.38	-0.03	2.20
		7	1.75	2.25	-1.58
		8	2.83	4.18	-3.48
		9	2.28	4.03	-1.33
		10	2.75	3.38	3.53
		11	1.60	1.18	-0.13
		12	2.15	2.20	0.73
	90 sec	1	3.85	2.20	0.78
		2	1.40	4.65	3.40
		3	2.30	1.68	2.78
		4	0.03	2.08	-0.20
		5	2.38	3.88	-0.23
		6	1.13	4.33	-2.45
		7	3.20	2.98	-3.18
		8	2.70	4.70	0.03
		9	2.40	3.80	2.20
		10	3.90	2.78	2.13
		11	1.50	3.15	-2.98
		12	2.73	0.98	-3.53

Contd....

Deflector	Retention Intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.23	3.10	1.23
		2	1.26	1.75	0.69
		3	0.19	-0.33	-1.75
		4	1.38	1.32	-1.03
		5	1.33	1.18	2.33
		6	1.38	-0.03	0.20
		7	1.75	2.23	-1.31
		8	2.83	4.18	-0.42
		9	2.45	0.03	-1.33
		10	2.75	3.38	3.33
		11	1.00	1.13	-0.13
		12	2.13	2.20	0.13
	90 sec	1	3.85	2.40	0.18
		2	1.40	4.03	3.00
		3	2.30	1.08	0.38
		4	0.03	2.38	-0.08
		5	2.38	3.48	-0.28
		6	3.13	4.33	-0.48
		7	3.80	2.38	-0.18
		8	2.70	4.70	0.03
		9	2.40	3.68	2.48
		10	3.80	2.78	0.13
		11	1.80	3.13	-2.08
		12	2.73	0.08	-1.23

3.106

APPENDIX 3.XXIII (CONTD.)

DISTANCE

Distraction	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	3.23	0.90	-8.78
		2	2.03	-5.80	-3.25
		3	0.50	-8.00	-12.05
		4	8.63	5.40	-1.50
		5	5.53	8.93	1.63
		6	3.63	3.18	-7.83
		7	4.08	0.25	-7.33
		8	4.08	0.48	-8.73
		9	2.53	-4.20	-7.43
		10	2.25	-1.55	-8.25
		11	6.13	-2.32	-4.93
		12	1.03	-1.88	-7.35
	90 sec	1	5.50	1.48	-12.30
		2	6.00	-1.40	-13.95
		3	8.50	-8.43	-13.80
		4	11.33	8.50	-6.53
		5	15.73	10.50	-6.70
		6	4.88	6.55	-11.88
		7	5.85	-6.85	-11.05
		8	5.53	-0.35	-4.78
		9	5.90	-11.00	-11.88
		10	6.70	-6.08	-14.20
		11	7.10	3.88	-13.78
		12	5.28	-5.85	-14.23

Contd....

APPENDIX 3.XXIII (CONTD.)

Destraction	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.60	-2.15	-9.30
		2	3.50	-1.50	-6.18
		3	-1.18	-6.58	-12.05
		4	5.08	-5.63	-5.63
		5	9.10	8.58	4.68
		6	4.00	3.45	-5.35
		7	3.13	-2.23	-6.85
		8	2.55	-0.58	-3.93
		9	2.63	-2.93	-6.78
		10	2.28	-3.73	-3.63
		11	-6.05	-1.50	-8.00
		12	-0.20	-3.13	-9.28
	90 sec	1	-0.20	-3.83	-11.58
		2	3.68	-4.73	-4.03
		3	10,33	-7.98	-16.08
		4	8.33	7.33	-6.50
		5	15.45	13.60	0.50
		6	3.00	4.28	-3.68
		7	3.55	-0.88	-10.40
		8	5.90	-0.73	-7.15
		9	5.38	-3.55	-8.83
		10	3.73	-8.75	-12.65
		11	8.48	-1.18	-5.80
		12	2.28	-2.00	-12.53

Contd.....

3.108

APPENDIX 3.XXIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.35	-6.13	-3.83
		2	2.13	-5.00	-8.45
		3	0.18	-8.15	-12.13
		4	8.10	0.90	-1.78
		5	10.70	11.78	4.88
		6	4.70	4.25	-6.75
		7	2.45	1.93	-7.03
		8	4.63	0.50	-8.13
		9	2.68	1.33	-5.40
		10	0.45	-2.18	-7.53
		11	4.32	0.25	-6.20
		12	1.68	-3.70	-7.78
	90 sec	1	7.45	-4.93	-10.53
		2	3.70	-2.50	-9.33
		3	1.18	-4.73	-15.85
		4	6.68	7.30	3.35
		5	15.43	6.08	0.98
		6	5.80	5.70	-1.98
		7	3.98	-2.15	-9.78
		8	6.03	0.05	-14.40
		9	3.90	-3.45	-7.33
		10	1.60	-5.05	-13.20
		11	1.13	-1.90	-3.80
		12	2.30	-5.35	-14.85

3.109

APPENDIX 3.XXIV

AE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.48	0.78	1.40
		2	0.45	1.05	1.83
		3	0.63	0.83	1.48
		4	0.45	0.60	1.38
		5	1.35	1.73	1.73
		6	0.58	0.68	2.10
		7	0.15	0.18	1.63
		8	0.48	0.68	1.78
		9	0.75	1.28	1.18
		10	0.60	1.03	1.95
		11	0.35	1.43	1.45
		12	1.15	1.68	1.18
	90 sec	1	0.45	0.75	2.03
		2	0.48	0.55	1.08
		3	1.23	0.68	1.53
		4	0.15	1.43	1.60
		5	1.28	1.75	1.88
		6	0.33	0.78	2.20
		7	0.35	0.93	2.00
		8	1.00	1.20	2.15
		9	1.03	1.23	1.63
		10	1.13	1.30	2.30
		11	0.48	1.18	3.25
		12	1.25	1.50	1.95

Contd...

3.110

APPENDIX 3.XXIV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	2.23	2.13	2.40
		2	1.78	1.85	2.40
		3	1.55	1.68	1.73
		4	1.40	0.88	2.78
		5	1.20	1.50	2.55
		6	1.78	1.70	2.63
		7	2.10	2.48	2.93
		8	2.40	2.13	2.75
		9	1.63	2.00	2.55
		10	1.38	2.07	2.13
		11	1.15	1.88	0.95
		12	1.15	1.05	2.70
	90 sec	1	3.38	2.53	3.98
		2	2.23	2.40	2.50
		3	2.60	2.58	4.00
		4	2.55	2.53	3.43
		5	2.28	1.88	2.20
		6	2.68	2.45	2.80
		7	4.48	3.63	4.35
		8	3.13	3.45	3.73
		9	1.73	2.00	2.53
		10	2.98	2.48	3.48
		11	0.88	0.68	2.58
		12	1.13	1.68	2.98

Contd.....

Dictractor	Retention intervals	Subjects	Targets (in cm.)	
			10	20
Counting	20 sec	1	2.23	2.13
		2	1.70	1.85
		3	1.55	1.60
		4	1.40	0.80
		5	1.20	1.50
		6	1.70	1.70
		7	2.10	2.40
		8	2.20	2.13
		9	1.63	2.00
		10	1.30	2.37
		11	1.15	1.08
		12	1.15	1.05
	90 sec	1	3.38	2.50
		2	2.23	2.40
		3	2.60	2.30
		4	2.55	2.33
		5	2.20	1.60
		6	2.60	2.15
		7	4.20	3.03
		8	3.13	3.45
		9	1.73	2.00
		10	2.90	2.40
		11	0.80	1.00
		12	1.13	1.03

Contd.....

3.111

APPENDIX 3.XXIV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.68	0.68	2.73
		2	2.03	1.33	1.68
		3	1.30	1.70	2.80
		4	0.70	2.00	2.43
		5	1.48	1.25	2.50
		6	0.93	1.90	2.10
		7	1.80	2.15	2.30
		8	1.85	1.93	2.78
		9	1.03	1.58	2.15
		10	1.98	2.30	2.03
		11	1.08	1.60	1.43
		12	0.65	1.90	2.63
	90 sec	1	1.63	1.90	3.15
		2	1.75	1.43	2.53
		3	1.83	1.70	3.00
		4	1.70	1.45	3.18
		5	1.88	1.85	3.28
		6	0.78	1.85	2.78
		7	3.28	3.45	3.38
		8	3.13	3.50	3.98
		9	1.48	1.83	1.58
		10	1.80	3.43	2.33
		11	1.35	1.10	2.65
		12	1.45	2.20	2.58

Contd.....

3.112

APPENDIX 3.XXIV (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	3.00	3.53	6.68
		2	2.60	2.83	5.95
		3	3.73	4.50	6.50
		4	3.35	5.38	4.93
		5	3.43	2.58	4.55
		6	2.65	4.80	3.78
		7	3.43	3.83	4.75
		8	2.00	4.33	8.25
		9	2.63	3.38	3.80
		10	2.43	3.03	4.00
		11	3.10	3.33	6.15
		12	2.85	3.73	6.48
	90 sec	1	5.30	5.05	7.58
		2	4.40	5.88	10.00
		3	6.00	6.13	9.88
		4	3.28	5.05	2.83
		5	2.48	3.18	4.08
		6	3.13	4.55	5.48
		7	5.43	6.33	10.58
		8	2.38	5.18	6.15
		9	4.28	5.48	8.78
		10	4.48	5.23	8.58
		11	5.70	5.68	9.38
		12	4.40	3.95	10.30

Contd.....

3.113

APPENDIX 3.XXIV (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	2.80	4.03	6.50
		2	2.88	2.88	6.23
		3	3.93	3.93	7.00
		4	2.43	5.85	7.95
		5	3.00	3.90	6.50
		6	3.15	3.73	4.85
		7	4.00	3.80	5.60
		8	2.88	4.68	4.60
		9	2.25	3.40	5.05
		10	3.23	2.75	5.01
		11	3.30	2.98	5.50
		12	2.95	3.05	8.78
	90 sec	1	4.28	5.35	9.13
		2	4.85	4.55	8.40
		3	5.25	6.23	7.00
		4	5.88	5.98	4.08
		5	4.88	3.85	4.90
		6	3.63	3.00	3.90
		7	5.88	6.68	10.45
		8	1.68	3.63	5.85
		9	4.05	5.08	7.58
		10	2.90	4.38	7.30
		11	2.33	4.63	8.33
		12	2.80	2.80	10.60

Contd.....

Distractors	Retention Intervals	Subjects	Targets (in sec.)	
			15	25
Counting	20 sec	1	2.80	4.05
		2	2.80	2.80
		3	3.95	3.95
		4	2.45	3.55
		5	3.00	3.00
		6	3.75	3.75
		7	4.00	3.50
		8	2.80	4.00
		9	2.85	3.00
		10	3.25	2.75
		11	3.30	2.90
		12	2.95	3.05
	30 sec	1	2.20	3.35
		2	4.85	4.55
		3	3.25	2.25
		4	3.80	3.30
		5	4.01	3.05
		6	3.65	3.00
		7	3.20	2.60
		8	1.80	3.00
		9	4.05	3.00
		10	3.30	3.30
		11	2.35	4.65
		12	2.80	3.30

3.114

APPENDIX 3.XXIV (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.55	3.95	6.88
		2	2.48	2.65	5.68
		3	4.00	3.70	6.38
		4	3.25	7.13	7.23
		5	2.63	4.10	4.30
		6	3.98	5.25	4.55
		7	3.28	3.83	6.03
		8	1.93	3.55	6.75
		9	2.75	2.65	5.80
		10	2.63	2.53	5.45
		11	3.08	2.83	6.30
		12	2.95	3.55	7.98
	90 sec	1	5.20	5.08	8.50
		2	4.90	4.88	8.13
		3	5.73	5.25	8.50
		4	3.05	6.23	5.45
		5	3.80	4.25	5.45
		6	2.15	5.40	3.43
		7	5.80	5.13	9.35
		8	1.28	3.40	6.88
		9	4.85	4.65	7.20
		10	4.20	5.18	6.88
		11	3.63	4.50	5.30
		12	5.35	3.65	8.95

Contd....

APPENDIX 3.XIV (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)	
			10	20
Movement	20 sec	1	2.55	3.95
		2	2.45	2.65
		3	4.10	3.70
		4	3.25	7.13
		5	2.65	4.15
		6	3.95	5.25
		7	3.20	3.73
		8	1.93	3.55
		9	2.95	2.65
		10	2.63	2.53
		11	3.03	2.03
		12	2.95	3.55
	90 sec	1	5.20	5.00
		2	4.90	4.00
		3	5.73	5.25
		4	3.05	6.23
		5	3.80	4.25
		6	2.15	5.40
		7	5.80	5.13
		8	1.26	3.40
		9	4.85	4.65
		10	4.20	5.10
		11	3.63	4.50
		12	5.35	3.55

Contd....

3.115

APPENDIX 3.XXIV (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.35	1.38	1.40
		2	0.68	1.38	1.15
		3	0.45	1.20	2.78
		4	0.88	1.80	1.98
		5	0.98	0.70	1.80
		6	0.55	0.78	2.63
		7	0.75	0.88	1.13
		8	0.53	1.00	0.43
		9	0.80	1.08	1.03
		10	0.70	0.85	1.25
		11	0.30	1.28	2.10
		12	1.50	1.05	1.15
	90 sec	1	0.33	0.68	2.18
		2	0.90	1.65	1.75
		3	1.08	1.70	3.55
		4	1.08	1.38	1.20
		5	0.90	1.78	2.80
		6	0.85	1.35	1.13
		7	0.70	0.88	1.45
		8	0.80	0.83	1.20
		9	0.78	1.38	1.15
		10	0.80	1.38	1.45
		11	0.50	1.28	1.13
		12	0.80	1.83	1.03

Contd....

3.116

APPENDIX 3.XXIV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.48	2.10	3.80
		2	1.70	1.50	2.15
		3	1.58	1.45	2.83
		4	1.53	2.40	3.50
		5	1.78	2.58	4.50
		6	1.65	2.03	2.10
		7	1.43	1.53	3.05
		8	1.45	2.38	0.98
		9	1.75	1.18	2.35
		10	1.40	1.75	3.53
		11	1.18	1.58	1.83
		12	1.95	1.65	2.08
	90 sec	1	4.08	3.43	3.45
		2	4.80	5.88	5.00
		3	4.15	1.88	3.88
		4	5.28	3.25	2.95
		5	5.03	4.40	4.53
		6	2.98	3.03	4.75
		7	4.93	5.18	3.88
		8	1.88	2.18	4.50
		9	2.08	3.13	2.00
		10	3.50	1.95	3.50
		11	2.68	3.05	4.55
		12	2.83	2.35	4.53

Contd.....

APPENDIX 3.XXIV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.33	3.43	2.85
		2	1.30	2.80	2.80
		3	2.58	2.73	4.40
		4	3.33	3.05	1.33
		5	2.43	2.80	3.98
		6	3.28	2.93	2.55
		7	2.08	2.58	3.25
		8	2.05	2.25	2.70
		9	2.08	2.70	1.75
		10	4.08	1.98	1.63
		11	0.95	1.75	2.48
		12	1.68	1.73	2.90
	90 sec	1	2.85	2.20	2.93
		2	2.65	3.95	4.48
		3	3.28	3.45	3.10
		4	6.70	5.65	2.80
		5	2.58	4.65	3.93
		6	2.78	4.68	4.58
		7	3.05	2.33	4.00
		8	2.85	3.63	2.10
		9	1.13	2.50	3.75
		10	3.95	3.98	3.80
		11	2.40	3.45	3.99
		12	2.43	2.20	3.58

Contd...

APPENDIX 3.XXIV (CONTD.)

Distinction	Detection intervals	Subjects	Targets (in cm.)		
			1σ	2σ	3σ
Movement	20 sec	1	1.39	3.43	5.85
		2	1.30	2.80	5.07
		3	2.52	6.73	4.80
		4	3.33	7.05	1.39
		5	2.43	2.80	7.98
		6	3.28	2.93	6.55
		7	2.08	2.50	3.29
		8	2.05	2.25	2.71
		9	2.04	2.71	1.75
		10	4.18	1.90	1.63
		11	0.95	1.75	2.22
		12	1.66	1.73	2.5
	90 sec	1	2.85	5.20	2.93
		2	2.65	3.95	4.47
		3	3.28	3.45	3.10
		4	6.78	5.65	2.20
		5	2.93	4.65	3.00
		6	2.78	4.68	4.98
		7	3.05	2.33	4.4
		8	2.05	3.63	2.10
		9	1.13	2.50	3.75
		10	3.05	3.98	3.4
		11	2.40	3.45	3.09
		12	2.43	2.2	2.39

Contd...

3.118

APPENDIX 3.XXIV (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	1.98	3.13	6.80
		2	4.30	1.50	6.75
		3	5.40	4.68	8.15
		4	1.90	2.25	4.63
		5	2.70	4.33	5.60
		6	6.70	2.00	6.25
		7	9.25	3.35	8.23
		8	6.93	1.85	7.75
		9	2.90	4.08	6.45
		10	4.33	1.60	3.75
		11	2.03	4.53	10.93
		12	2.78	2.70	10.35
	90 sec	1	3.18	4.33	8.73
		2	5.80	1.95	7.05
		3	4.98	5.75	10.40
		4	4.70	3.50	10.48
		5	3.68	4.03	10.25
		6	10.25	2.08	6.23
		7	11.25	5.83	10.00
		8	7.53	3.23	5.48
		9	7.05	5.33	8.45
		10	4.73	3.50	13.25
		11	2.25	5.08	10.05
		12	4.08	3.43	11.30

Contd.....

3.119

APPENDIX 3.XXIV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	4.25	2.83	6.63
		2	5.68	2.03	7.73
		3	4.68	3.80	3.58
		4	3.43	2.23	6.03
		5	4.73	4.18	9.43
		6	6.83	3.50	5.63
		7	8.03	2.85	6.25
		8	4.95	1.45	3.55
		9	4.20	3.30	7.43
		10	3.70	3.03	6.68
		11	2.53	5.00	11.00
		12	1.48	1.98	5.65
	90 sec	1	1.98	4.03	10.03
		2	6.88	1.43	4.50
		3	4.60	3.88	10.63
		4	3.55	5.65	6.85
		5	3.23	3.25	10.25
		6	7.80	2.58	5.28
		7	12.43	4.25	9.00
		8	6.88	4.60	6.58
		9	3.45	5.80	8.18
		10	5.40	7.60	7.08
		11	7.05	3.98	10.43
		12	5.35	3.43	6.88

Contd....

3.120

APPENDIX 3.XXIV (CONTD.)

Distructor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	3.48	3.40	4.88
		2	3.33	1.43	7.75
		3	4.38	3.40	6.68
		4	4.05	2.45	3.58
		5	2.45	4.28	6.90
		6	8.85	6.40	2.95
		7	7.73	3.58	7.00
		8	7.58	4.70	3.55
		9	4.43	4.15	8.13
		10	3.13	3.18	6.43
		11	2.73	4.25	9.68
		12	1.95	3.80	2.23
	90 sec	1	6.08	5.30	4.73
		2	5.80	0.55	8.05
		3	4.73	3.43	6.03
		4	5.60	3.78	6.65
		5	4.18	4.65	7.38
		6	10.58	5.55	4.33
		7	8.20	3.78	10.00
		8	7.55	2.75	3.78
		9	6.55	3.78	7.88
		10	6.13	3.28	9.58
		11	7.20	2.95	11.60
		12	2.95	1.20	1.45

3.1.21

APPENDIX 3.XXV

VE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.50	0.63	1.42
		2	0.55	0.96	2.09
		3	0.58	0.90	1.65
		4	0.52	0.63	1.58
		5	1.53	1.54	1.75
		6	0.62	0.89	2.22
		7	1.20	0.20	1.27
		8	0.40	0.75	1.40
		9	0.92	1.29	1.36
		10	0.51	1.13	1.05
		11	0.39	1.33	0.74
		12	0.96	1.73	1.61
	90 sec	1	0.48	0.76	1.93
		2	0.39	0.56	1.14
		3	1.28	0.18	1.56
		4	0.19	1.65	1.01
		5	0.88	1.30	1.91
		6	0.11	0.69	0.41
		7	0.11	0.26	0.34
		8	0.41	0.73	0.84
		9	0.88	1.27	1.63
		10	0.58	1.21	2.31
		11	0.68	1.68	3.32
		12	1.27	1.24	1.53

Contd.....

3.1.22

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.90	0.19	0.64
		2	1.31	1.38	1.92
		3	1.57	1.68	1.75
		4	0.62	0.88	2.90
		5	1.33	0.75	2.17
		6	1.90	1.77	0.98
		7	0.10	2.49	2.45
		8	0.36	2.16	1.92
		9	1.15	1.12	2.76
		10	1.56	2.12	1.39
		11	1.04	0.89	0.95
		12	1.25	1.01	2.01
	90 sec	1	1.26	2.33	3.36
		2	2.25	0.31	2.77
		3	2.21	2.21	0.31
		4	2.58	2.30	3.01
		5	2.05	1.89	2.38
		6	1.91	1.42	2.98
		7	0.94	0.29	0.54
		8	2.48	3.57	1.15
		9	1.93	2.00	2.56
		10	3.01	1.00	2.69
		11	0.82	0.73	2.63
		12	1.14	0.41	2.38

Contd....

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.70	0.60	2.35
		2	0.57	1.35	1.54
		3	1.23	1.92	2.07
		4	0.21	1.57	2.45
		5	1.53	1.45	2.52
		6	1.18	1.82	2.20
		7	0.31	0.57	1.86
		8	0.61	0.33	0.80
		9	0.11	1.65	2.22
		10	0.33	1.95	2.19
		11	1.26	1.58	1.52
		12	0.72	1.37	2.09
	90 sec	1	1.69	0.97	2.46
		2	0.57	1.32	2.13
		3	2.02	0.47	2.59
		4	1.75	0.71	2.83
		5	1.97	1.86	1.04
		6	0.86	2.11	3.15
		7	2.86	0.46	3.61
		8	0.89	3.53	3.63
		9	1.40	1.85	1.73
		10	0.92	2.92	2.71
		11	1.08	1.16	3.18
		12	1.25	1.84	1.18

Contd....

APPENDIX 3.XIV (CONTD.)

Distractor	Reaction time intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.70	0.60	1.39
		2	0.57	1.35	1.34
		3	1.23	1.02	2.07
		4	0.21	1.27	2.45
		5	1.53	1.45	2.32
		6	1.18	1.32	2.20
		7	0.31	0.27	1.86
		8	0.61	0.23	0.89
		9	0.11	1.65	2.02
		10	0.23	1.45	2.19
		11	1.21	1.38	1.82
		12	0.72	1.27	2.09
	30 sec	1	1.69	0.27	2.26
		2	0.57	1.32	2.13
		3	2.02	0.47	2.39
		4	1.73	0.73	2.83
		5	1.97	1.36	1.24
		6	0.85	2.11	3.15
		7	2.86	0.48	3.01
		8	0.89	2.13	3.80
		9	1.10	1.81	1.73
		10	0.92	2.02	2.11
		11	1.04	1.14	3.19
		12	1.25	1.84	1.48

3.124

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.32	2.82	5.73
		2	2.09	2.48	0.86
		3	2.89	3.44	6.54
		4	2.57	1.34	4.21
		5	0.94	2.65	4.54
		6	2.67	4.38	4.73
		7	0.70	0.73	0.90
		8	1.85	1.72	1.50
		9	2.41	0.41	3.49
		10	1.95	3.05	1.46
		11	0.27	0.49	1.44
		12	2.90	3.04	3.93
	90 sec	1	0.71	4.38	1.55
		2	3.49	0.74	1.37
		3	1.06	5.46	2.07
		4	1.04	4.38	2.90
		5	2.63	3.62	4.15
		6	2.71	1.76	1.40
		7	4.78	1.01	1.59
		8	1.35	5.37	5.98
		9	1.13	0.97	1.59
		10	0.37	4.43	1.12
		11	1.70	4.88	1.60
		12	1.95	3.86	2.33

Contd.....

3.125

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	0.53	3.34	0.61
		2	2.43	2.89	1.31
		3	0.60	0.19	0.71
		4	2.40	4.34	1.32
		5	2.66	3.55	6.64
		6	2.99	1.92	4.59
		7	0.55	0.41	1.54
		8	3.36	1.44	4.35
		9	1.91	3.05	3.69
		10	0.90	2.37	0.80
		11	0.67	2.46	0.79
		12	0.91	3.07	4.17
	90 sec	1	0.73	4.60	0.22
		2	0.63	3.92	0.48
		3	1.41	5.23	3.35
		4	2.71	6.03	4.24
		5	4.92	3.78	4.37
		6	2.85	3.03	2.36
		7	0.54	6.71	0.79
		8	1.47	3.34	2.17
		9	1.34	4.69	0.85
		10	0.97	3.88	1.03
		11	1.08	4.63	1.16
		12	1.79	3.15	1.78

Contd.....

Determinator	Retention intervals	Subjects	Targets (in cm.)	
			10	20
Counting	20 sec	1	0.53	3.34
		2	2.45	2.89
		3	0.60	0.79
		4	2.40	4.34
		5	2.66	3.57
		6	2.99	3.92
		7	0.55	0.47
		8	3.36	4.44
		9	1.91	3.05
		10	0.90	2.37
		11	0.67	2.46
		12	0.94	3.07
	90 sec	1	0.73	4.60
		2	0.63	3.92
		3	1.47	5.23
		4	2.71	6.03
		5	4.02	3.72
		6	2.85	3.08
		7	0.54	6.71
		8	1.47	3.34
		9	1.34	4.69
		10	0.97	3.08
		11	1.08	4.40
		12	1.74	3.15

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.73	3.76	1.98
		2	[illegible]	[illegible]	0.34
		3	1.27	3.70	0.41
		4	2.88	4.85	6.03
		5	2.36	2.82	4.38
		6	4.17	3.08	3.81
		7	0.28	3.87	4.79
		8	1.80	0.30	2.86
		9	2.15	2.83	1.61
		10	2.63	2.53	2.18
		11	0.26	2.83	0.74
		12	2.30	3.56	3.63
	90 sec	1	4.06	4.84	0.79
		2	0.71	4.93	0.54
		3	0.40	0.75	7.24
		4	2.30	2.93	2.38
		5	1.68	3.94	4.11
		6	1.89	5.03	4.19
		7	1.32	0.93	1.94
		8	1.63	0.85	3.82
		9	0.79	4.03	1.75
		10	0.54	5.19	1.14
		11	1.14	3.78	3.01
		12	0.90	3.53	1.28

Contd.....

APPENDIX 3.XXV (CONTD.)

BLIND

LOCATION

Distraction	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.24	1.40	1.39
		2	0.57	1.51	1.30
		3	0.42	1.18	1.67
		4	0.19	0.41	0.84
		5	0.36	0.54	1.07
		6	0.21	0.87	0.48
		7	0.48	0.93	0.90
		8	0.48	0.30	0.54
		9	0.23	1.11	0.87
		10	0.14	0.45	1.34
		11	0.61	0.61	1.60
		12	0.41	1.31	0.52
	90 sec	1	0.37	0.50	0.60
		2	0.51	1.82	1.87
		3	0.56	1.67	3.18
		4	0.93	0.62	1.30
		5	0.26	0.58	1.85
		6	0.92	1.24	1.22
		7	0.52	0.83	1.65
		8	0.35	0.95	1.30
		9	0.79	1.19	1.19
		10	0.51	1.09	1.39
		11	0.19	0.81	1.08
		12	0.60	1.86	0.39

Contd....

3.128

APPENDIX 3.XXV (CONTD.

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.19	1.93	2.84
		2	0.46	1.56	2.22
		3	0.83	0.92	2.85
		4	0.26	0.72	3.72
		5	0.20	0.48	1.16
		6	0.85	2.06	2.10
		7	0.29	1.54	0.88
		8	1.26	0.62	1.01
		9	1.63	0.84	2.76
		10	0.32	0.61	3.86
		11	0.91	1.62	1.86
		12	0.83	1.72	0.99
	90 sec	1	2.08	3.67	0.78
		2	3.18	1.63	2.76
		3	0.95	0.97	4.19
		4	2.51	0.90	4.05
		5	1.22	3.10	1.92
		6	0.66	3.28	0.43
		7	1.46	4.72	3.96
		8	1.55	1.04	0.52
		9	1.31	2.94	2.14
		10	1.22	1.43	3.54
		11	2.10	3.45	1.62
		12	1.42	2.40	1.41

Contd.....

3.129

APPENDIX XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.27	3.44	3.06
		2	0.92	2.56	3.04
		3	2.44	2.53	0.87
		4	1.63	0.64	0.73
		5	0.83	1.50	1.35
		6	2.89	3.10	2.61
		7	1.25	2.19	3.52
		8	0.79	1.92	3.19
		9	0.98	2.81	1.15
		10	0.37	1.06	1.87
		11	0.50	1.11	2.57
		12	0.34	2.18	2.33
	90 sec	1	1.89	1.28	2.12
		2	1.49	1.67	3.94
		3	0.85	1.88	1.68
		4	0.92	0.98	2.82
		5	1.08	2.85	2.81
		6	1.35	4.80	3.65
		7	1.68	2.75	0.45
		8	0.54	1.61	2.18
		9	0.96	2.78	3.29
		10	0.53	1.47	4.04
		11	1.23	2.68	3.96
		12	0.70	1.48	1.32

Contd....

Disturbance	Retention Interval	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.27	3.44	3.00
		2	0.92	2.30	3.04
		3	2.44	2.53	0.87
		4	1.03	0.84	0.73
		5	0.83	1.80	1.35
		6	2.89	3.10	2.61
		7	1.25	2.79	3.72
		8	0.73	1.98	3.79
		9	0.92	2.81	1.13
		10	0.77	1.06	1.87
		11	0.50	1.11	0.37
		12	0.34	2.16	2.37
	30 sec	1	1.89	1.98	2.12
		2	1.49	1.67	3.04
		3	0.85	1.82	1.62
		4	0.92	0.98	2.82
		5	1.08	2.85	2.87
		6	1.35	4.00	3.03
		7	1.68	2.73	0.42
		8	0.54	1.61	2.17
		9	0.96	2.72	3.13
		10	0.53	1.47	4.04
		11	1.23	2.60	3.09
		12	0.70	1.40	1.38

Contd....

3.130

APPENDIX 3.XXV (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	1.68	3.88	1.81
		2	1.45	1.51	1.68
		3	1.81	2.26	2.71
		4	0.47	1.77	1.92
		5	1.51	0.88	0.39
		6	2.39	1.01	1.71
		7	7.82	3.42	1.97
		8	2.81	2.12	2.82
		9	1.73	3.16	2.17
		10	0.81	1.69	0.43
		11	1.65	0.99	0.78
		12	1.39	2.83	1.43
	90 sec	1	0.79	3.10	2.54
		2	1.93	1.87	1.54
		3	2.58	5.80	2.32
		4	2.52	1.73	4.03
		5	1.79	0.54	2.91
		6	2.02	2.56	1.90
		7	2.80	5.83	1.90
		8	2.51	2.25	2.00
		9	2.58	5.30	7.06
		10	0.97	3.62	2.64
		11	2.42	5.18	1.57
		12	1.78	2.24	0.91

Contd.....

Distractor	Retention interval	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	1.68	3.08	1.47
		2	1.45	1.47	1.68
		3	1.81	2.26	2.71
		4	0.47	1.77	1.98
		5	1.31	0.88	0.70
		6	2.39	1.07	1.77
		7	1.82	3.42	1.97
		8	2.81	2.12	2.06
		9	1.73	3.16	2.77
		10	0.67	1.09	0.43
		11	1.65	0.99	0.78
		12	1.39	2.83	1.43
	90 sec	1	0.79	3.10	2.04
		2	1.93	1.87	1.54
		3	2.38	3.80	2.32
		4	2.02	1.73	2.89
		5	1.79	0.24	2.91
		6	2.06	2.36	1.90
		7	2.30	3.89	1.80
		8	2.51	1.23	2.36
		9	2.38	0.30	2.06
		10	0.97	3.68	2.04
		11	2.42	3.18	1.37
		12	1.74	2.24	0.97

3.131

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.39	2.84	1.95
		2	3.27	2.31	1.57
		3	1.68	3.37	0.70
		4	2.08	2.44	1.98
		5	2.56	1.12	1.67
		6	1.83	2.52	1.33
		7	2.82	2.56	1.79
		8	1.32	1.98	3.59
		9	3.24	3.46	1.29
		10	1.33	3.06	1.86
		11	1.76	0.12	3.69
		12	0.83	1.96	3.40
	90 sec	1	1.68	4.52	1.92
		2	6.47	1.58	0.85
		3	4.94	4.02	2.70
		4	1.49	5.56	2.49
		5	2.70	2.26	1.42
		6	3.50	1.71	0.91
		7	10.38	4.28	2.10
		8	1.92	4.83	2.26
		9	4.20	5.89	2.05
		10	2.52	7.60	0.63
		11	2.53	4.25	2.30
		12	1.75	2.32	0.80

Contd...

3.132

APPENDIX 3.XXV (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	1.82	2.99	2.48
		2	2.62	1.85	2.15
		3	0.79	3.48	2.04
		4	1.20	2.74	2.47
		5	1.79	3.72	2.92
		6	2.78	6.74	2.24
		7	1.32	2.79	2.55
		8	3.58	0.94	1.23
		9	3.08	4.20	3.26
		10	1.15	3.19	3.17
		11	3.29	4.50	7.40
		12	0.71	3.95	1.99
	90 sec	1	3.08	4.43	4.76
		2	1.93	0.68	1.66
		3	1.40	3.49	1.10
		4	2.07	3.52	1.72
		5	3.07	3.47	1.61
		6	2.53	2.91	2.63
		7	7.13	3.53	3.26
		8	1.11	1.77	3.75
		9	1.47	3.82	3.58
		10	1.96	3.30	2.79
		11	3.92	4.03	2.38
		12	1.02	1.59	1.61

Distractor	Retention Intervals	Subjects	Targets (in cm.)	
			10	30
Movement	20 sec	1	1.82	
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		
	30 sec	1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		

3.133

APPENDIX 3.XXVI

CE SCORES OF SUBJECTS ON VERTICAL TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.28	0.53	0.25
		2	0.30	0.70	0.23
		3	0.63	0.08	0.48
		4	0.30	-0.40	-0.48
		5	0.30	0.88	0.58
		6	-0.33	0.13	-1.35
		7	1.15	0.18	-1.13
		8	0.28	0.58	-1.13
		9	0.50	-0.53	0.53
		10	0.60	0.63	1.95
		11	-0.10	-0.58	-1.45
		12	-0.70	-0.28	0.38
	90 sec	1	0.15	0.05	-0.78
		2	-0.38	0.10	-0.58
		3	0.43	0.68	0.08
		4	0.00	0.18	-1.50
		5	1.13	1.30	0.33
		6	-0.33	-0.48	-2.20
		7	0.35	0.93	-2.00
		8	1.00	1.20	-2.15
		9	0.83	-0.30	-0.88
		10	1.13	0.55	1.30
		11	-0.08	0.28	-0.80
		12	-0.55	1.10	1.50

Contd....

APPENDIX 3.XXVI

DE SCORES OF SUBJECTS ON VERBAL TASK IN EXPERIMENT 3.6

STORIES

Distractor	Retention Intervals	Subjects	Targets (in cm.)	
			10	20
Control	20 sec	1	0.38	0.59
		2	0.30	0.70
		3	0.63	0.08
		4	0.30	-0.40
		5	0.30	0.88
		6	-0.33	0.13
		7	1.15	0.18
		8	0.28	0.58
		9	0.50	-0.53
		10	0.60	0.63
		11	-0.10	-0.58
		12	-0.70	-0.28
	90 sec	1	0.15	0.05
		2	-0.38	0.10
		3	0.43	0.68
		4	0.00	0.18
		5	1.13	1.30
		6	-0.33	-0.43
		7	0.35	0.93
		8	1.00	1.20
		9	0.83	-0.30
		10	1.13	0.55
		11	-0.08	0.28
		12	-0.35	1.10

Contd....

3.134

APPENDIX 3.XXVI (CONTD.)

Distractor	Retnetion intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.18	-2.13	-2.40
		2	1.63	1.35	-1.50
		3	0.20	0.33	-0.48
		4	1.40	0.53	-0.48
		5	-0.30	-1.50	1.40
		6	0.58	0.05	-2.63
		7	2.10	0.33	-1.63
		8	2.40	0.38	-2.25
		9	1.53	2.00	-0.95
		10	1.38	0.53	-1.98
		11	0.75	1.88	-0.95
		12	-0.10	-0.45	1.95
	90 sec	1	3.38	1.08	-2.18
		2	0.38	-2.40	0.25
		3	1.40	1.33	4.00
		4	-0.20	1.08	-2.03
		5	1.08	0.63	-1.35
		6	-2.23	-2.45	0.25
		7	4.48	3.63	-4.35
		8	2.03	0.30	-3.73
		9	-0.33	0.15	1.73
		10	0.18	2.48	2.43
		11	0.88	0.33	-0.43
		12	0.73	1.68	2.03

Contd.....

Detector	Detection intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	1.72	-2.13	-2.40
		2	1.69	1.35	-1.32
		3	0.20	0.33	-0.23
		4	1.40	0.33	-0.40
		5	-0.30	-1.30	1.40
		6	0.34	0.05	-2.03
		7	2.10	0.33	-1.03
		8	2.40	0.34	-2.03
		9	1.33	2.00	-0.95
		10	1.38	0.33	-1.38
		11	0.75	1.02	-0.95
		12	-0.10	-0.43	1.85
	90 sec	1	3.38	1.08	-2.38
		2	0.33	-2.40	0.23
		3	1.40	1.33	4.00
		4	-0.20	1.08	-2.03
		5	1.08	0.83	-1.33
		6	-2.23	-2.43	0.25
		7	4.48	3.43	-4.35
		8	2.03	0.30	-3.73
		9	-0.33	0.13	1.73
		10	0.18	2.42	2.43
		11	0.08	0.33	-0.43
		12	0.73	1.43	2.03

Contd.....

3.135

APPENDIX 3.XXVI (CONTD.)

Distracter	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	-0.33	0.38	0.38
		2	2.03	0.78	-0.78
		3	0.85	1.05	2.30
		4	0.70	1.30	-0.13
		5	0.38	0.15	0.55
		6	0.28	-0.65	0.55
		7	1.80	2.15	-1.50
		8	1.85	1.93	-2.78
		9	1.03	0.13	0.80
		10	1.98	1.25	-0.03
		11	0.08	-0.50	1.03
		12	-0.35	1.55	1.68
	90 sec	1	-0.58	1.90	2.15
		2	-1.75	-0.68	1.38
		3	-0.13	1.70	1.55
		4	0.85	-1.45	-1.48
		5	0.08	-1.05	3.28
		6	0.63	0.55	-0.53
		7	1.68	3.45	-1.63
		8	3.13	0.40	-1.68
		9	-1.28	-1.33	1.28
		10	1.80	-1.83	1.03
		11	0.95	0.10	-0.25
		12	0.75	1.25	2.58

Contd....

Dilatator	Retention intervals	Subjects	Targets (in cm.)	
			10	20
Movement	20 sec	1	-0.33	
		2	2.03	
		3	0.89	
		4	0.70	
		5	0.31	
		6	0.26	
		7	1.30	
		8	1.85	
		9	1.09	
		10	1.96	
		11	0.08	
		12	-0.35	
	30 sec	1	-0.53	
		2	-1.75	
		3	-0.13	
		4	0.85	
		5	0.08	
		6	0.85	
		7	1.68	
		8	3.13	
		9	-1.28	
		10	1.80	
		11	0.95	
		12	0.75	

3.136

APPENDIX 3.XXVI (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.00	2.28	-3.68
		2	1.60	-1.43	-5.95
		3	2.48	2.25	-0.75
		4	2.60	-5.88	-3.53
		5	3.43	0.78	-1.55
		6	-0.75	-2.45	-0.48
		7	-3.43	-3.83	-4.75
		8	1.05	-4.33	-8.25
		9	-1.13	-3.38	-1.90
		10	1.68	-0.48	-4.00
		11	3.10	-3.33	-6.15
		12	0.95	-2.23	-6.48
	90 sec	1	5.30	2.55	-7.58
		2	2.90	-5.88	-10.00
		3	6.00	2.83	-9.88
		4	3.28	2.55	2.28
		5	1.48	0.73	-3.63
		6	1.58	-4.55	-5.48
		7	2.63	-6.33	-10.58
		8	-2.38	-0.28	-2.60
		9	4.28	-5.48	-8.78
		10	4.48	-2.88	-8.58
		11	5.70	-2.93	-9.38
		12	4.40	-1.95	-10.30

Contd.....

APPENDIX 3.XXVI (CONTD.)

DISTANCE

Deflector	Retention interval	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	2.00	2.22	-3.68
		2	1.60	-1.43	-5.95
		3	2.42	2.25	-0.75
		4	2.60	-3.32	-3.33
		5	3.43	0.70	-1.55
		6	-0.75	-2.45	-0.42
		7	-3.43	-3.03	-4.75
		8	1.05	-4.33	-4.25
		9	-1.13	-3.38	-1.90
		10	1.65	-0.43	-4.00
		11	3.10	-3.33	-6.15
		12	0.95	-2.23	-6.42
	90 sec	1	5.30	2.55	-7.38
		2	2.90	-5.68	-10.00
		3	6.00	2.03	-9.05
		4	3.20	2.33	2.23
		5	1.48	0.73	-3.07
		6	1.50	-4.33	-5.23
		7	2.63	-6.43	-10.13
		8	-2.38	-0.23	-4.00
		9	4.28	-5.47	-4.38
		10	4.48	-2.03	-5.20
		11	5.70	-4.93	-9.32
		12	4.40	-1.93	-10.30

Contd.....

3.137

APPENDIX 3.XXVI (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	2.80	-2.53	-6.50
		2	1.63	-0.18	-6.23
		3	3.93	3.93	-7.00
		4	0.93	9.90	7.95
		5	1.65	2.10	-1.45
		6	1.40	-3.73	-3.15
		7	4.00	3.80	-5.60
		8	-0.38	-4.68	-3.65
		9	1.35	-1.60	-3.80
		10	3.23	1.45	-5.15
		11	3.30	1.73	-5.50
		12	2.95	-0.50	-8.78
	90 sec	1	4.28	-2.85	-9.13
		2	4.85	-2.35	-8.40
		3	5.25	-3.48	-7.00
		4	5.88	-2.98	-1.83
		5	0.73	2.25	-3.35
		6	2.68	0.50	3.90
		7	5.88	-0.33	-10.45
		8	-0.93	-1.93	-5.85
		9	4.05	2.08	-7.58
		10	2.90	-2.38	-7.30
		11	2.33	-0.23	-8.33
		12	2.80	-0.30	-10.60

Contd.....

3.138

APPENDIX 3.XXVI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	2.55	1.95	-6.88
		2	2.48	-1.25	-5.68
		3	4.00	0.10	-6.38
		4	2.05	5.88	-5.13
		5	1.78	3.80	-1.90
		6	-0.33	5.25	2.65
		7	3.28	0.68	-3.78
		8	-0.83	-3.55	-6.75
		9	2.00	-0.40	-5.80
		10	0.53	0.03	-5.45
		11	3.08	-0.08	-6.30
		12	1.95	-0.10	-7.98
	90 sec	1	3.45	1.83	-8.50
		2	4.90	0.13	-8.13
		3	5.73	5.25	- 4.50
		4	3.05	6.23	5.45
		5	3.80	2.50	-4.70
		6	1.30	2.90	-0.78
		7	5.80	5.13	-9.35
		8	-0.18	-3.40	-6.88
		9	4.85	-2.35	-7.20
		10	4.20	-0.33	-6.88
		11	3.63	-2.50	-5.30
		12	5.35	1.90	-8.95

Contd.....

3.139

APPENDIX 3.XXVI (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	0.30	0.58	-1.25
		2	0.53	0.23	0.15
		3	0.45	0.60	-2.78
		4	0.88	1.80	1.98
		5	0.98	0.70	1.80
		6	0.55	0.18	-2.63
		7	0.75	-0.23	0.83
		8	0.28	1.00	0.18
		9	0.80	0.03	-0.93
		10	0.70	0.85	-0.90
		11	0.30	1.28	-1.90
		12	1.50	-0.25	-1.15
	90 sec	1	-0.08	0.28	-2.18
		2	0.90	0.25	-0.10
		3	1.08	1.45	-1.70
		4	0.73	1.38	-0.20
		5	0.90	1.78	2.80
		6	0.50	0.55	-0.28
		7	0.70	0.73	0.05
		8	0.80	0.03	-0.20
		9	0.68	0.98	0.20
		10	0.80	1.38	0.85
		11	0.50	1.28	-0.63
		12	0.80	0.78	-1.03

Contd.....

3.140

APPENDIX 3.XXVI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	0.98	0.90	-3.45
		2	1.70	0.35	-0.55
		3	1.58	1.45	-1.98
		4	1.53	2.40	2.10
		5	1.78	2.58	4.50
		6	1.65	0.93	-0.20
		7	1.48	-0.43	-3.05
		8	1.20	2.38	-0.13
		9	1.05	1.03	0.10
		10	1.40	1.75	0.53
		11	0.80	0.73	0.18
		12	1.95	-0.65	-2.08
	90 sec	1	4.08	-0.88	-3.45
		2	4.20	5.88	-5.00
		3	4.15	-1.88	-1.53
		4	5.27	3.25	0.90
		5	5.03	4.40	4.53
		6	2.98	0.28	-4.75
		7	4.93	3.08	-0.23
		8	1.13	-2.50	-4.50
		9	2.08	1.18	0.85
		10	3.50	1.45	-1.40
		11	2.03	-0.25	-4.95
		12	2.83	0.15	-4.53

Contd.....

3.141

APPENDIX 3.XXVI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	0.93	1.33	-1.00
		2	1.25	1.40	1.20
		3	0.98	1.48	-4.40
		4	3.33	3.05	1.33
		5	2.43	2.80	3.98
		6	2.88	1.23	-0.90
		7	2.08	1.43	-0.50
		8	2.05	1.25	-0.05
		9	2.08	0.50	1.75
		10	4.08	1.98	-0.23
		11	0.95	-1.75	-0.08
		12	1.68	0.63	-2.00
	90 sec	1	2.85	2.20	2.93
		2	2.65	3.95	-4.48
		3	3.28	3.45	-3.10
		4	6.70	5.65	0.80
		5	2.58	4.45	3.43
		6	2.78	0.98	-2.93
		7	3.05	1.38	4.00
		8	2.85	3.63	-0.50
		9	0.68	0.75	-2.40
		10	3.95	3.98	2.25
		11	2.40	2.55	-1.68
		12	2.43	2.05	-3.58

Contd.....

3.142

APPENDIX 3.XXVI (CONTD..)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Control	20 sec	1	1.98	-1.13	-6.80
		2	4.30	-0.65	-6.75
		3	5.40	-4.68	-8.15
		4	1.90	-1.75	-4.63
		5	2.70	-4.33	-5.60
		6	6.70	-2.00	-6.25
		7	5.00	-0.75	-8.73
		8	6.93	-0.60	-7.75
		9	2.90	-3.08	-6.45
		10	4.33	0.55	-3.75
		11	1.43	-4.53	-10.93
		12	2.78	-1.40	-10.35
	90 sec	1	3.18	-3.33	-8.73
		2	5.80	0.90	-7.05
		3	4.98	4.75	-10.40
		4	4.70	-3.50	-10.48
		5	3.68	-4.03	-10.25
		6	10.25	0.03	-6.43
		7	11.25	0.98	-10.00
		8	7.53	-2.63	-5.48
		9	7.05	-1.93	-5.00
		10	4.73	-0.60	-13.25
		11	1.40	0.73	-10.05
		12	4.08	-3.43	-11.30

Contd.....

143

APPENDIX 3.XXVI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Counting	20 sec	1	4.25	-0.33	-6.63
		2	5.68	-0.33	-7.73
		3	4.68	2.20	-3.58
		4	3.43	-1.43	-6.03
		5	4.73	-4.18	-9.43
		6	6.83	3.50	-5.63
		7	8.03	1.35	-6.25
		8	4.95	-0.45	-3.55
		9	2.95	-0.65	-7.43
		10	3.70	1.78	-6.68
		11	2.53	-5.00	-11.00
		12	1.48	-1.58	-5.65
	90 sec	1	1.38	-0.08	-10.03
		2	3.43	0.38	-4.50
		3	0.85	0.43	-10.63
		4	3.55	2.15	-6.85
		5	3.23	-3.00	-10.25
		6	7.80	2.58	-5.28
		7	7.58	-0.80	-9.00
		8	6.88	0.50	-6.58
		9	-0.30	-0.70	-8.18
		10	5.40	4.60	-7.08
		11	7.05	-0.08	-10.43
		12	5.35	-3.43	-6.88

Contd....

3.144

APPENDIX 3.XXVI (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			10	20	30
Movement	20 sec	1	3.48	1.80	-4.88
		2	3.33	0.18	-7.75
		3	4.38	1.90	-6.68
		4	4.05	-1.45	-3.58
		5	1.95	-2.48	-6.90
		6	8.85	0.45	-2.20
		7	7.73	2.33	-7.00
		8	7.58	4.70	-3.55
		9	4.43	0.75	-8.13
		10	3.13	0.78	-6.43
		11	2.33	2.40	-6.78
		12	1.95	-1.40	-1.83
	90 sec.	1	6.98	4.05	-3.63
		2	5.80	-0.45	-8.05
		3	4.73	-0.73	-6.03
		4	5.60	-1.88	-6.65
		5	3.18	-4.35	-7.88
		6	10.58	5.55	-4.33
		7	4.85	-2.03	-10.00
		8	7.55	2.75	-1.23
		9	6.55	0.93	-7.38
		10	6.13	1.93	-9.58
		11	7.20	0.90	-11.60
		12	2.95	-0.10	0.15

3.145

APPENDIX 3.XXVII

AE SCORES OF SUBJECTS ON CURVILENEAR TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distructors	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	2.00	2.50	7.25
		2	2.25	4.50	6.25
		3	0.75	2.00	6.25
		4	1.00	2.25	4.25
		5	1.50	2.50	4.75
		6	1.50	3.25	5.00
		7	1.50	2.25	3.50
		8	1.25	2.75	7.00
		9	0.50	1.25	4.25
		10	2.50	4.50	6.00
		11	2.75	4.00	4.75
		12	2.75	4.45	5.75
	90 sec	1	2.25	3.75	5.25
		2	2.25	3.50	4.25
		3	0.75	2.50	3.00
		4	1.00	0.25	5.25
		5	2.25	2.50	5.25
		6	0.75	2.00	6.50
		7	1.25	3.75	4.00
		8	1.75	3.75	7.00
		9	1.75	2.25	4.25
		10	2.25	2.75	5.75
		11	1.25	4.00	2.00
		12	1.50	2.00	5.25

Contd.....

3.146

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	3.25	6.00	9.75
		2	5.50	9.25	9.50
		3	4.75	8.75	7.25
		4	5.24	6.50	9.25
		5	7.75	8.00	9.50
		6	25.50	8.25	10.75
		7	7.00	9.25	8.75
		8	4.25	6.00	5.00
		9	7.50	7.25	9.25
		10	4.25	6.25	4.25
		11	7.00	7.50	10.25
		12	3.50	7.25	9.25
	90 sec	1	5.00	7.75	13.50
		2	5.00	7.50	12.50
		3	5.50	7.25	12.75
		4	7.50	11.50	12.00
		5	12.50	12.75	14.25
		6	8.50	7.25	11.00
		7	9.50	11.75	13.50
		8	8.50	5.75	10.00
		9	13.25	13.75	13.25
		10	4.50	5.75	5.50
		11	9.00	11.25	17.00
		12	10.75	10.50	16.00

Contd.....

3.147

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	3.75	6.00	10.00
		2	5.00	8.25	10.25
		3	3.00	6.75	7.25
		4	4.75	5.50	7.50
		5	5.75	7.00	8.00
		6	2.00	4.75	7.00
		7	6.25	6.50	7.25
		8	4.25	5.50	7.25
		9	4.25	6.25	10.50
		10	3.75	8.75	5.75
		11	3.00	3.50	6.50
		12	2.00	4.25	7.00
	90 sec	1	6.25	7.50	7.75
		2	8.75	9.25	14.50
		3	6.50	5.00	6.25
		4	5.25	9.00	10.25
		5	7.75	9.50	8.25
		6	4.00	5.00	9.50
		7	8.00	18.50	8.75
		8	6.25	5.25	5.00
		9	8.25	9.25	11.00
		10	4.75	6.25	7.25
		11	5.25	5.25	9.75
		12	7.00	5.50	13.25

Contd.....

3.148

APPENDIX 3.XXVII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	17.00	6.75	12.00
		2	12.25	11.75	18.25
		3	16.00	14.00	19.25
		4	19.25	12.25	23.75
		5	15.00	11.50	4.25
		6	2.25	6.25	15.50
		7	15.00	15.75	24.50
		8	9.75	9.00	16.75
		9	8.50	12.25	20.75
		10	10.50	8.50	30.00
		11	6.50	7.25	5.50
		12	13.50	17.25	15.75
	90 sec	1	28.25	32.00	28.75
		2	13.00	13.00	22.25
		3	28.25	23.25	34.00
		4	28.00	23.00	42.00
		5	16.50	15.75	9.75
		6	13.50	7.75	15.00
		7	25.00	21.75	40.00
		8	14.75	10.25	15.00
		9	17.00	21.00	40.75
		10	15.50	14.75	37.25
		11	9.75	7.25	9.00
		12	23.75	19.75	24.25

Contd.....

DISTANCE				
Distractor	Retention Intervals	Subjects	Subjects (in Deg.)	
Control	20 sec	1	17.00	
		2	12.25	
		3	16.00	
		4	19.25	
		5	15.00	
		6	2.25	
		7	15.00	
		8	9.75	
		9	8.50	
		10	10.50	
		11	6.50	
		12	13.50	
	90 sec	1	20.25	
		2	12.00	
		3	28.25	
		4	24.00	
		5	16.50	
		6	13.50	
		7	25.00	
		8	16.75	
		9	17.00	
		10	15.50	
		11	9.75	
		12	23.75	

3.149

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	15.75	16.75	23.75
		2	7.50	10.00	17.00
		3	16.00	9.00	19.25
		4	15.25	15.25	25.00
		5	11.75	10.25	5.75
		6	3.50	14.50	11.00
		7	19.25	16.75	33.50
		8	8.25	13.25	14.75
		9	10.00	11.50	19.25
		10	7.50	13.00	28.25
		11	7.25	8.00	5.50
		12	11.00	11.00	14.00
	90 sec	1	27.75	16.25	24.25
		2	5.75	9.00	25.75
		3	22.25	21.75	31.75
		4	30.00	20.50	33.00
		5	12.25	14.75	5.25
		6	2.25	11.00	11.00
		7	18.75	27.50	29.50
		8	15.00	16.50	7.50
		9	17.50	17.75	39.75
		10	9.00	9.75	32.50
		11	12.50	5.00	10.25
		12	21.75	18.50	26.25

Contd.....

Obstructor	Retention Intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	15.75	16.75	23.75
		2	7.50	10.00	17.00
		3	16.00	9.00	19.25
		4	15.25	15.25	25.00
		5	11.75	10.25	5.75
		6	3.50	14.50	11.00
		7	19.25	16.75	33.50
		8	8.25	13.25	16.75
		9	10.00	11.50	19.25
		10	7.50	15.00	26.25
		11	7.25	8.00	5.50
		12	11.00	11.00	14.00
	90 sec	1	27.75	16.25	24.25
		2	5.75	9.00	25.75
		3	22.25	21.75	31.75
		4	30.00	20.50	33.00
		5	12.25	14.75	5.25
		6	2.25	11.00	11.00
		7	16.75	27.50	29.50
		8	15.00	16.50	7.50
		9	17.50	17.75	29.75
		10	9.00	9.75	32.50
		11	12.50	5.00	10.25
		12	21.75	13.50	26.25

Contd.....

3.150

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in deg.)		
			30	70	110
Movement	20 sec	1	20.50	14.00	16.75
		2	17.25	11.50	9.00
		3	15.00	13.50	21.00
		4	23.50	14.25	26.75
		5	10.25	9.75	5.25
		6	4.00	9.00	12.00
		7	16.75	12.50	26.00
		8	5.75	10.75	17.25
		9	10.50	13.50	19.50
		10	6.25	10.25	21.25
		11	5.75	7.50	10.25
		12	11.75	10.00	17.50
	90 sec	1	20.50	22.00	23.50
		2	9.50	9.25	14.25
		3	23.00	22.75	28.00
		4	29.75	24.00	32.00
		5	11.00	13.75	6.25
		6	4.25	7.25	19.50
		7	23.25	22.75	34.50
		8	6.50	12.75	14.75
		9	7.25	21.25	25.75
		10	10.25	8.25	28.00
		11	4.25	13.25	7.75
		12	25.00	20.00	29.50

Contd.....

3.151

APPENDIX 3.XXVII (CONTD.)

BLINDS

LOCATION

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	1.00	3.00	3.25
		2	1.00	1.25	3.50
		3	1.50	4.00	4.00
		4	2.00	2.00	2.25
		5	2.25	4.25	4.25
		6	1.50	3.25	6.50
		7	2.25	3.75	4.25
		8	2.75	2.00	4.75
		9	3.00	3.00	7.50
		10	3.00	3.75	8.75
		11	3.00	2.75	7.50
		12	2.00	3.50	2.00
	90 sec	1	3.25	2.50	2.50
		2	2.00	2.75	4.00
		3	1.00	2.50	3.25
		4	2.50	3.50	4.25
		5	3.75	3.00	4.50
		6	2.00	3.00	4.75
		7	1.25	2.00	5.25
		8	1.55	2.75	4.75
		9	1.75	3.00	6.00
		10	1.25	2.50	3.75
		11	2.50	4.50	7.50
		12	2.25	2.25	3.25

Contd.....

3.152

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	3.50	6.25	4.75
		2	13.00	3.25	5.75
		3	4.75	7.25	5.75
		4	8.75	6.00	3.75
		5	16.50	8.75	10.75
		6	4.75	2.50	11.00
		7	3.50	4.25	4.00
		8	13.50	7.00	13.50
		9	1.75	10.75	13.50
		10	7.00	4.75	6.50
		11	3.50	8.00	15.25
		12	4.00	5.25	8.75
	90 sec	1	6.50	9.50	6.25
		2	19.00	6.25	11.50
		3	14.75	8.00	8.75
		4	8.50	8.50	6.75
		5	20.25	8.25	18.25
		6	10.50	9.25	14.75
		7	3.00	3.50	5.50
		8	15.00	2.75	25.75
		9	7.00	8.50	15.50
		10	12.50	7.25	8.75
		11	6.75	9.00	10.25
		12	4.50	4.00	12.25

Contd.....

3.153

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets(in deg.)		
			30	70	110
Movement	20 sec	1	6.00	5.75	5.00
		2	10.00	3.75	4.75
		3	2.50	3.25	7.25
		4	6.50	5.75	4.25
		5	15.00	9.50	14.25
		6	2.00	4.75	12.75
		7	4.00	6.00	7.75
		8	7.50	6.75	20.25
		9	2.50	9.75	14.25
		10	7.75	8.25	11.25
		11	4.75	7.50	10.50
		12	4.50	2.75	4.75
	90 sec	1	4.75	5.75	10.00
		2	9.25	6.00	6.00
		3	4.75	7.75	4.75
		4	8.75	3.25	9.75
		5	20.00	12.00	14.50
		6	3.00	9.00	16.75
		7	13.25	6.50	8.00
		8	12.50	9.00	23.50
		9	4.25	9.25	11.50
		10	11.50	5.00	7.25
		11	4.50	9.00	10.00
		12	7.00	6.00	6.75

Contd.....

Distractor	Retention intervals	Subjects	Target data (deg.)	
			30	70
Movement	20 sec.	1	6.00	5.75
		2	10.00	3.75
		3	2.50	3.25
		4	6.50	5.75
		5	15.00	9.50
		6	2.00	4.75
		7	4.00	6.00
		8	7.50	6.75
		9	2.50	9.75
		10	7.75	8.25
		11	4.75	7.50
		12	4.50	2.75
	70 sec.	1	4.75	5.75
		2	9.25	6.00
		3	4.75	7.75
		4	0.75	3.25
		5	20.00	12.00
		6	5.00	9.00
		7	13.25	6.50
		8	12.50	1.00
		9	4.25	8.25
		10	11.50	3.00
		11	4.50	4.00
		12	7.00	6.00

3.154

APPENDIX 3.XXVII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	15.75	14.25	21.75
		2	9.50	9.00	26.00
		3	18.00	6.25	31.00
		4	2.25	10.25	18.00
		5	8.50	10.00	24.00
		6	7.00	17.00	30.25
		7	13.50	4.00	29.00
		8	4.50	10.00	27.25
		9	10.75	15.50	41.25
		10	17.50	14.75	29.25
		11	20.50	16.50	18.50
		12	24.75	5.50	22.25
	90 sec	1	16.25	10.00	23.00
		2	13.50	5.75	21.00
		3	16.50	14.00	46.50
		4	1.25	18.25	18.50
		5	8.25	6.75	27.50
		6	10.50	8.00	22.00
		7	30.00	3.00	43.00
		8	5.00	15.00	33.50
		9	17.00	18.75	37.75
		10	16.75	17.25	37.25
		11	27.75	15.00	29.50
		12	33.75	16.75	44.25

Contd.....

3.155

APPENDIX 3.XXVII (CONTD.)

Distructors	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	19.50	20.25	26.75
		2	11.50	12.00	27.25
		3	14.25	8.75	3250
		4	3.25	17.75	32.50
		5	7.50	9.50	33.75
		6	8.25	19.00	28.50
		7	22.50	3.75	36.75
		8	9.25	11.00	26.25
		9	15.00	12.75	31.00
		10	12.25	11.75	24.25
		11	20.50	11.50	29.00
		12	23.00	10.50	23.50
	90 sec	1	23.50	12.25	22.25
		2	17.50	10.25	26.50
		3	31.75	11.25	44.75
		4	9.50	17.00	36.25
		5	11.75	11.75	33.75
		6	6.75	17.75	35.75
		7	34.25	10.75	37.75
		8	7.25	21.25	42.75
		9	18.75	13.50	40.75
		10	23.50	13.25	34.00
		11	18.75	11.00	25.75
		12	29.50	13.75	38.00

Contd.....

3.156

APPENDIX 3.XXVII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	16.00	18.50	18.75
		2	6.50	7.25	30.25
		3	12.75	12.00	41.75
		4	3.25	6.50	14.50
		5	13.25	7.25	29.25
		6	5.50	8.75	27.25
		7	30.50	6.50	33.75
		8	4.50	8.75	27.25
		9	12.75	16.00	38.75
		10	17.25	12.25	24.00
		11	18.50	6.50	12.75
		12	25.00	13.75	27.25
	90 sec	1	20.75	15.25	26.50
		2	9.00	7.25	29.70
		3	13.00	8.25	32.50
		4	7.25	13.75	14.25
		5	16.75	7.50	34.25
		6	9.75	14.75	38.25
		7	26.75	10.00	43.50
		8	3.50	10.00	31.00
		9	19.50	15.25	36.75
		10	23.25	14.00	23.00
		11	29.75	20.25	20.00
		12	34.00	23.25	24.75

3.157

APPENDIX 3.XXVIII

VE S(ORES OF SUBJECTS ON CUR ILENEAR TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distractors	Retnetion intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	2.06	2.69	1.48
		2	2.86	4.18	6.50
		3	1.09	2.50	6.38
		4	1.12	2.49	1.10
		5	1.12	1.66	0.83
		6	1.22	2.95	2.92
		7	1.32	1.92	1.50
		8	1.79	2.95	6.96
		9	0.71	1.30	1.09
		10	2.74	5.15	6.10
		11	0.83	6.52	5.07
		12	0.43	3.70	6.18
	90 sec	1	2.59	4.20	4.97
		2	2.59	2.06	4.39
		3	1.09	3.20	3.39
		4	0.71	0.43	0.83
		5	1.48	2.96	1.48
		6	0.83	2.45	5.55
		7	1.48	3.34	2.69
		8	1.92	2.28	5.50
		9	1.30	2.49	0.83
		10	2.17	1.92	7.29
		11	1.30	4.58	0.00
		12	1.80	1.80	2.49

Contd....

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	3.27	2.55	9.09
		2	2.50	9.34	7.89
		3	1.30	7.50	5.63
		4	0.43	6.58	1.64
		5	2.49	7.58	1.12
		6	37.35	6.68	3.49
		7	1.22	1.09	2.49
		8	4.76	3.16	5.41
		9	1.12	0.43	7.95
		10	2.04	5.40	4.49
		11	7.45	5.79	6.06
		12	4.42	7.69	1.64
	90 sec	1	3.39	7.89	11.73
		2	1.00	2.96	1.66
		3	1.66	1.92	12.87
		4	2.06	2.06	1.58
		5	1.66	1.92	1.09
		6	7.52	5.93	4.64
		7	3.20	11.80	2.29
		8	7.23	6.06	1.73
		9	0.83	1.79	2.17
		10	4.97	5.12	5.55
		11	9.49	4.02	2.00
		12	3.34	1.66	16.13

Contd.....

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	2.95	4.50	7.97
		2	4.53	8.35	4.60
		3	3.64	5.76	1.30
		4	1.09	4.64	1.66
		5	1.64	6.18	0.71
		6	2.24	4.44	6.89
		7	0.83	6.50	0.83
		8	4.44	2.18	6.22
		9	1.09	6.30	5.36
		10	2.05	7.43	2.28
		11	3.35	3.94	6.54
		12	2.18	2.50	1.73
	90 sec	1	0.83	7.78	7.50
		2	1.30	7.36	2.50
		3	2.29	5.32	5.67
		4	3.11	0.71	9.73
		5	2.49	8.28	1.48
		6	3.94	5.13	2.69
		7	3.16	10.61	0.83
		8	4.49	5.36	2.55
		9	1.48	7.98	9.85
		10	5.26	5.49	6.87
		11	5.40	4.71	9.36
		12	5.68	2.50	2.86

Contd.....

3.160

APPENDIX 3.XXVIII (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	1.73	4.32	4.95
		2	4.60	1.48	2.95
		3	3.08	12.97	1.30
		4	4.15	11.52	21.10
		5	6.48	11.93	4.71
		6	2.28	6.42	6.54
		7	4.30	14.96	2.18
		8	2.05	8.83	15.20
		9	8.65	12.38	2.59
		10	8.17	8.96	4.90
		11	6.69	7.36	2.18
		12	2.96	13.10	14.31
	90 sec	1	3.11	13.58	23.85
		2	9.94	14.63	5.49
		3	0.43	19.24	2.92
		4	4.30	17.55	37.26
		5	5.17	1.48	3.34
		6	16.65	8.56	15.03
		7	2.12	17.85	1.41
		8	15.16	10.43	15.08
		9	17.04	20.21	6.83
		10	9.73	3.83	7.50
		11	10.59	7.19	8.86
		12	6.65	20.20	18.65

Contd.....

3.161

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	5.40	12.97	22.47
		2	0.87	3.39	8.80
		3	2.45	7.50	16.45
		4	3.70	16.31	6.28
		5	8.44	10.40	5.07
		6	3.57	10.16	7.80
		7	2.38	16.22	5.85
		8	10.01	10.96	14.52
		9	5.05	10.14	16.82
		10	7.18	12.85	8.87
		11	7.50	8.20	1.80
		12	1.58	10.03	2.35
	90 sec	1	5.93	6.61	4.32
		2	4.97	3.67	3.77
		3	6.91	4.32	1.79
		4	5.96	19.46	22.10
		5	2.17	10.33	3.42
		6	2.49	8.22	9.98
		7	15.22	27.97	21.66
		8	12.30	10.84	3.64
		9	5.72	18.58	35.74
		10	9.71	12.44	7.23
		11	12.75	5.79	12.11
		12	4.66	14.17	23.24

Contd.....

3.162

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	2.69	6.12	2.49
		2	19.38	10.61	6.98
		3	2.12	2.06	2.92
		4	21.80	14.47	3.70
		5	4.71	10.99	5.40
		6	4.28	9.46	7.35
		7	15.12	12.66	2.92
		8	5.36	11.88	8.07
		9	0.87	2.29	3.20
		10	5.93	10.40	6.50
		11	6.57	8.06	6.87
		12	2.28	8.44	0.87
	90 sec	1	7.43	3.74	20.01
		2	7.83	9.50	9.55
		3	18.95	18.71	3.08
		4	9.52	1.41	4.42
		5	8.29	5.93	4.49
		6	4.60	3.49	14.94
		7	22.41	5.12	7.23
		8	2.69	12.99	7.83
		9	0.83	21.95	20.17
		10	5.07	5.54	26.78
		11	3.56	13.79	6.30
		12	6.48	21.23	4.72

Contd.....

APPENDIX 3.XXVIII (CONTD.)

BLIND

LOCATION

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	1.41	1.87	3.11
		2	0.71	1.48	2.29
		3	1.58	3.08	5.39
		4	0.71	2.87	1.48
		5	2.17	1.48	0.83
		6	2.18	1.30	3.77
		7	1.79	3.11	4.44
		8	2.28	2.24	4.44
		9	3.50	1.73	2.50
		10	1.41	1.48	6.98
		11	2.35	3.11	4.82
		12	2.35	3.84	1.87
	90 sec	1	3.03	1.50	3.20
		2	1.00	2.86	1.73
		3	1.22	3.08	3.27
		4	1.66	3.84	2.86
		5	1.64	3.39	3.20
		6	2.55	1.73	1.92
		7	0.83	2.24	5.58
		8	2.18	3.03	2.17
		9	0.83	1.22	1.00
		10	0.83	2.96	4.44
		11	1.87	4.53	7.78
		12	1.92	0.83	3.27

Contd.....

3.164

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in cm.)		
			30	70	110
Counting	20 sec	1	2.06	4.82	4.82
		2	1.58	3.63	1.79
		3	1.92	2.95	6.50
		4	4.02	5.02	0.43
		5	7.16	9.04	8.32
		6	3.27	1.87	4.12
		7	3.35	2.05	4.82
		8	5.59	1.58	6.80
		9	1.79	1.48	4.50
		10	6.75	3.70	6.20
		11	1.66	6.20	9.55
		12	1.41	5.45	3.49
	90 sec	1	3.77	9.01	7.29
		2	3.67	6.87	10.27
		3	5.67	8.25	3.27
		4	1.80	8.67	6.91
		5	10.11	2.50	3.96
		6	3.35	3.49	0.83
		7	1.00	4.03	2.60
		8	3.94	2.17	10.01
		9	4.30	4.50	7.23
		10	6.02	8.50	7.50
		11	3.56	8.15	7.79
		12	2.29	4.95	6.57

Contd.....

APPENDIX 3.XXVIII (CONTD.)

Instructor	Retention intervals	Subjects	Targets (in sec.)		
			30	70	110
Covering	20 sec	1	2.06	4.02	4.82
		2	1.38	3.63	1.77
		3	1.96	2.45	6.50
		4	4.02	5.02	0.42
		5	7.16	9.04	3.36
		6	3.07	1.27	4.76
		7	3.35	2.05	4.26
		8	5.39	1.50	6.30
		9	1.79	1.44	4.30
		10	6.75	3.70	4.32
		11	1.66	6.20	7.43
		12	1.47	5.45	3.43
	30 sec	1	3.27	9.07	7.42
		2	3.69	6.27	10.27
		3	5.69	8.35	3.47
		4	1.00	2.07	6.47
		5	10.11	2.50	3.38
		6	3.35	3.43	6.03
		7	1.00	4.03	2.00
		8	3.94	2.17	10.04
		9	4.30	4.30	7.43
		10	6.02	4.20	7.30
		11	3.36	6.13	3.78
		12	2.39	4.42	6.37

Contd.....

3.165

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	0.71	1.92	4.64
		2	2.45	3.11	1.79
		3	2.74	3.63	3.11
		4	5.17	6.50	3.03
		5	14.99	9.23	10.50
		6	1.22	2.68	2.86
		7	2.12	6.52	10.57
		8	4.61	8.32	5.89
		9	2.18	10.54	3.11
		10	3.70	10.26	10.43
		11	1.92	7.58	2.29
		12	2.06	2.86	5.07
	90 sec	1	1.30	4.92	9.21
		2	2.59	6.71	6.04
		3	5.21	8.14	2.95
		4	3.27	3.56	6.72
		5	7.38	10.36	4.39
		6	3.64	3.54	3.34
		7	9.44	5.89	10.01
		8	16.32	9.34	6.94
		9	3.34	4.82	6.96
		10	5.12	5.68	6.53
		11	3.81	8.60	10.31
		12	4.18	6.10	6.87

Contd.....

APPENDIX 3.XXVIII (CONTD.)

DISTANCE					
Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	5.21	14.10	1.30
		2	3.35	10.68	7.87
		3	19.27	7.66	9.19
		4	2.28	11.90	8.15
		5	4.03	7.04	3.67
		6	7.70	11.05	5.40
		7	26.91	3.39	6.40
		8	4.82	1.22	5.07
		9	2.49	4.33	1.09
		10	6.50	8.79	8.41
		11	3.20	13.58	14.04
		12	6.42	5.61	1.92
	90 sec	1	5.07	10.59	9.98
		2	5.50	7.40	3.67
		3	8.90	12.39	4.72
		4	1.30	10.89	4.72
		5	6.65	5.31	5.94
		6	16.52	6.23	9.72
		7	11.23	2.83	3.94
		8	5.39	4.12	8.38
		9	4.24	1.92	5.17
		10	4.97	17.47	4.60
		11	4.71	5.39	7.63
		12	5.49	15.79	3.77

Contd.....

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	2.18	20.36	6.30
		2	6.54	11.72	3.56
		3	18.62	8.79	4.15
		4	3.70	16.33	13.43
		5	2.87	1.66	8.76
		6	4.21	4.30	14.31
		7	20.48	3.96	4.71
		8	12.89	6.04	5.71
		9	8.57	3.77	3.81
		10	11.88	9.04	4.97
		11	3.84	9.67	5.79
		12	2.92	10.61	10.14
	90 sec	1	6.34	5.80	4.55
		2	6.50	8.26	8.38
		3	17.09	11.61	6.76
		4	12.86	3.54	7.38
		5	4.02	11.78	5.93
		6	9.44	18.14	7.73
		7	31.63	10.06	5.59
		8	1.92	8.93	7.79
		9	4.26	6.80	5.31
		10	4.61	14.31	4.58
		11	21.08	11.75	11.12
		12	8.68	12.36	3.08

Contd.....

3.168

APPENDIX 3.XXVIII (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	4.64	15.32	6.38
		2	3.35	7.56	7.15
		3	3.70	12.73	10.92
		4	3.34	7.83	1.12
		5	4.44	6.50	7.50
		6	5.43	6.14	9.96
		7	13.32	9.17	5.43
		8	4.85	4.87	9.20
		9	3.70	14.99	3.27
		10	3.96	12.79	8.10
		11	2.06	6.58	2.86
		12	5.34	12.88	3.70
	90 sec	1	6.83	9.76	8.62
		2	0.71	10.16	11.32
		3	9.51	1.30	8.56
		4	7.50	13.81	8.44
		5	6.06	7.81	5.12
		6	4.49	5.54	12.81
		7	24.82	5.48	7.79
		8	3.04	10.05	10.30
		9	3.84	4.27	34.32
		10	8.17	14.98	5.87
		11	6.50	6.10	5.87
		12	7.55	18.14	12.48

APPENDIX 3.XXIX

CE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.6

SIGHTED

LOCATION

Distructdr	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	1.50	-0.50	7.25
		2	0.25	-2.00	-0.75
		3	-0.25	0.50	1.25
		4	0.50	-0.75	-4.25
		5	1.50	-2.50	-4.75
		6	-1.00	-3.25	-5.00
		7	-1.50	-2.25	-3.50
		8	-0.25	-2.25	-4.00
		9	0.00	0.25	-4.25
		10	0.00	1.00	-8.50
		11	2.75	-1.00	-0.75
		12	-2.75	-3.25	-1.75
	90 sec	1	0.75	1.25	-3.75
		2	1.25	3.50	-1.50
		3	0.25	0.50	-1.00
		4	1.00	0.25	-5.25
		5	2.25	-0.50	-5.25
		6	-0.75	0.00	-3.50
		7	0.25	-1.75	-3.50
		8	0.75	-3.75	-4.50
		9	1.25	-0.75	-4.25
		10	0.75	2.75	0.25
		11	1.25	1.00	-2.00
		12	0.50	-1.50	-5.25

Contd.....

3.170

APPENDIX 3.XXIX (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	-0.25	-6.00	-4.25
		2	5.50	-0.75	-5.50
		3	4.75	4.75	-5.25
		4	5.25	-0.50	-9.25
		5	7.75	3.00	-9.50
		6	25.50	-5.75	-10.75
		7	7.00	9.25	-8.75
		8	0.75	6.00	-0.50
		9	7.50	7.25	-4.75
		10	4.25	-4.25	-0.75
		11	1.00	-5.00	-10.25
		12	0.00	-0.25	-9.25
	90 sec	1	5.00	0.75	7.00
		2	5.00	7.50	-12.50
		3	5.50	7.25	-4.25
		4	7.50	-11.50	-12.00
		5	12.50	12.75	-14.25
		6	4.00	-4.25	-11.00
		7	9.50	0.25	-13.50
		8	4.50	-0.25	-10.00
		9	13.25	-13.75	-13.25
		10	1.50	-3.25	-2.50
		11	4.00	11.25	-17.00
		12	10.75	-10.50	-0.50

Contd.....

3.171

APPENDIX 3.XXIX (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	3.25	4.50	7.00
		2	3.00	1.25	-10.25
		3	0.50	4.25	-7.25
		4	-4.75	-3.00	-7.50
		5	-5.75	-3.50	-8.00
		6	1.00	2.75	-3.00
		7	6.25	1.50	-7.25
		8	-1.25	-5.50	3.75
		9	4.25	-0.25	-10.50
		10	3.75	5.25	-5.75
		11	0.50	-1.00	-2.50
		12	1.50	-4.25	-7.00
	90 sec	1	6.25	0.00	- 2.75
		2	8.75	-6.75	-14.50
		3	6.50	-2.50	-2.75
		4	5.25	-9.00	-3.75
		5	7.75	5.00	-8.25
		6	3.00	-0.50	-9.50
		7	8.00	-5.00	-8.75
		8	5.25	-1.25	-5.00
		9	8.25	5.75	-2.75
		10	0.75	3.75	-2.75
		11	2.25	-2.75	-4.25
		12	5.50	5.50	-13.25

Contd.....

3.172

PPENDIX 3.XXIX (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	17.00	6.75	-12.00
		2	12.25	11.75	-18.25
		3	16.00	7.50	-19.25
		4	19.25	-4.75	-11.25
		5	15.00	4.50	0.75
		6	0.75	-1.25	-15.50
		7	15.00	-6.25	-24.50
		8	9.75	4.00	-11.25
		9	0.50	-4.75	-20.75
		10	10.50	3.50	-30.00
		11	2.50	-2.25	5.50
		12	13.50	13.25	-6.75
	90 sec	1	28.25	32.00	-16.75
		2	9.50	10.00	-22.25
		3	28.25	13.75	-34.00
		4	28.00	10.00	-19.50
		5	16.50	15.75	-9.75
		6	-3.50	3.25	-11.00
		7	25.00	12.75	-40.00
		8	1.25	3.75	-4.00
		9	2.50	7.00	-40.75
		10	15.50	14.75	-37.25
		11	4.75	3.75	3.00
		12	23.75	0.25	-17.25

Contd.....

APPENDIX 3.XXIX (CONTD.)

Distructor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	15.75	11.75	-11.25
		2	17.50	10.00	-17.00
		3	16.00	6.50	-10.25
		4	15.25	2.75	-25.00
		5	9.75	-2.25	-2.75
		6	-0.50	-11.50	-9.50
		7	-19.25	5.75	-33.50
		8	1.75	8.75	-12.25
		9	10.00	-5.50	-9.75
		10	-3.00	5.00	-28.25
		11	5.25	2.50	-5.50
		12	11.00	-5.00	-14.00
	90 sec	1	27.75	16.25	-24.25
		2	3.25	9.00	-25.75
		3	22.25	21.75	-31.75
		4	30.00	-8.00	-28.00
		5	12.25	13.75	5.25
		6	-0.25	-9.00	-10.00
		7	11.25	1.50	-21.50
		8	-9.50	-1.00	-7.50
		9	17.50	-5.25	-17.75
		10	1.50	2.75	-32.50
		11	0.00	3.00	-5.75
		12	21.75	-12.50	-12.25

Contd.....

3.174

APPENDIX 3.XXIX (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	20.50	14.00	-16.75
		2	3.25	6.00	-8.50
		3	15.00	13.50	-21.00
		4	12.50	5.25	-26.75
		5	10.25	1.25	-3.75
		6	1.00	-5.00	-12.00
		7	8.25	-1.50	-26.00
		8	2.75	-3.25	-17.25
		9	10.50	-13.50	-19.50
		10	-2.75	-3.25	-21.25
		11	3.75	4.00	-10.75
		12	11.75	5.00	-17.50
	90 sec	1	20.50	22.00	-16.00
		2	8.50	3.75	-12.25
		3	13.50	3.25	-28.00
		4	29.75	24.00	-30.00
		5	8.50	13.75	5.25
		6	1.75	7.25	-14.50
		7	8.75	22.75	-34.50
		8	-6.50	-6.75	-14.75
		9	17.25	-0.75	-16.75
		10	10.25	-7.25	-13.00
		11	3.25	-2.75	5.25
		12	25.00	5.00	29.50

Contd.....

APPENDIX 3.XXIX (CONTD.)

BLINDS

LOCATION

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	0.00	-3.00	1.75
		2	1.00	0.25	-3.50
		3	1.00	-3.00	-3.00
		4	2.00	-0.50	-2.25
		5	0.75	4.25	-4.25
		6	0.50	-3.25	-6.50
		7	1.75	-2.25	0.25
		8	1.75	0.00	-4.75
		9	-0.50	-3.00	-7.50
		10	3.00	-3.75	-6.25
		11	2.00	0.25	-7.50
		12	0.00	-0.50	2.00
	90 sec	1	2.25	-2.50	0.50
		2	2.00	-2.25	-4.00
		3	1.00	0.00	-1.25
		4	2.50	0.50	-4.25
		5	3.75	0.00	-4.50
		6	0.00	-3.00	-4.75
		7	1.25	0.00	-1.25
		8	-0.50	-1.75	-4.75
		9	-1.75	-3.00	-6.00
		10	1.25	-1.50	0.25
		11	2.00	1.00	0.00
		12	1.25	-2.25	-0.25

Contd.....

3.176

APPENDIX 3.XXIX (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	3.50	-4.25	1.75
		2	13.00	-0.75	-5.75
		3	4.75	7.25	0.25
		4	8.75	3.50	-3.75
		5	16.50	4.75	-10.75
		6	4.25	-2.00	-11.00
		7	3.50	-4.25	-0.50
		8	13.50	-7.00	-13.50
		9	1.25	-10.75	-13.50
		10	7.00	-4.25	-5.00
		11	3.50	-8.00	-14.25
		12	4.00	-0.25	-8.75
	90 sec	1	6.50	-3.50	1.25
		2	19.00	-0.75	-8.00
		3	14.75	-1.00	-8.75
		4	8.50	2.50	-1.25
		5	20.25	8.25	-8.25
		6	10.50	9.25	-14.25
		7	3.00	-2.50	-5.50
		8	15.00	-1.75	-25.75
		9	7.00	-8.50	-15.50
		10	12.50	2.25	-7.75
		11	6.25	-4.00	-7.75
		12	4.50	.0.00	-12.25

Contd.....

3.177

APPENDIX 3.XXIX (CONTD.)

Distraction	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	6.00	-5.75	-4.00
		2	10.00	-2.25	-4.75
		3	1.00	0.25	-7.25
		4	6.50	-3.25	-4.25
		5	4.50	6.50	-14.25
		6	-2.00	-4.75	-12.75
		7	4.00	-3.00	-2.75
		8	7.50	0.75	-20.25
		9	1.50	3.75	-14.75
		10	7.75	1.25	-5.28
		11	4.75	6.00	-10.50
		12	4.50	-1.25	-2.75
	90 sec	1	4.75	-3.25	-7.50
		2	9.25	-1.00	-4.00
		3	3.75	-0.25	-4.75
		4	8.75	-1.75	-9.75
		5	20.00	9.50	-14.50
		6	0.50	-9.00	-16.75
		7	13.25	-3.50	-3.50
		8	1.00	-2.50	-23.50
		9	-2.75	-9.25	-11.00
		10	11.50	2.50	-3.25
		11	4.00	4.00	2.50
		12	7.00	0.50	-1.25

Contd.....

3.17φ

APPENDIX 3.XXIX (CONTD.)

DISTANCE

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Control	20 sec	1	15.75	-5.75	-21.75
		2	9.50	0.00	-26.00
		3	18.00	-0.25	-31.00
		4	0.75	-3.25	-18.00
		5	8.50	-10.00	-24.00
		6	1.50	-16.00	-30.25
		7	15.00	3.00	-29.00
		8	1.50	-10.00	-27.25
		9	10.75	-15.50	-41.25
		10	17.50	-14.75	-29.25
		11	20.50	-10.00	-14.50
		12	24.75	1.00	-22.25
	90 sec	1	16.25	-3.50	-23.00
		2	13.50	2.75	-21.00
		3	16.50	-10.00	-46.50
		4	0.25	17.75	-18.50
		5	8.25	-5.75	-27.50
		6	-9.50	-5.50	-22.00
		7	30.00	2.00	-43.00
		8	0.00	-15.00	-33.50
		9	17.00	-18.75	-37.75
		10	16.75	-0.25	-37.25
		11	27.75	-15.00	-29.50
		12	33.75	7.75	-44.25

Contd.....

3.179

APPENDIX 3.XXIX (CONTD.)

Distractors	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1	19.50	9.75	-26.75
		2	11.50	9.50	-27.25
		3	-2.75	-1.75	-32.50
		4	0.75	8.75	-32.50
		5	7.50	-9.50	-33.75
		6	8.25	-19.00	-28.50
		7	10.00	0.25	-36.75
		8	-3.75	-11.00	-26.25
		9	15.00	-12.75	-31.00
		10	7.25	-9.25	-24.25
		11	20.50	-7.00	-29.00
		12	23.00	-4.00	-23.50
	90 sec	1	23.50	-12.25	-22.25
		2	17.50	6.75	-26.50
		3	31.75	4.25	-44.75
		4	-6.50	-17.00	-36.25
		5	11.75	3.75	-33.75
		6	6.75	-8.75	-35.75
		7	15.75	-5.75	-37.75
		8	7.25	-21.25	-42.75
		9	18.75	-13.50	-40.75
		10	23.50	-2.75	-34.00
		11	1.25	4.00	-25.75
		12	29.50	6.25	-38.00

Contd.....

Departures	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Counting	20 sec	1			
		2			
		3			
		4			
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			
	90 sec	1			
		2			
		3			
		4			
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			

3.180

APPENDIX 3.XXIX (CONTD.)

Distractor	Retention intervals	Subjects	Targets (in Deg.)		
			30	70	110
Movement	20 sec	1	16.00	-12.50	-18.75
		2	6.50	-3.75	-30.25
		3	12.75	-1.50	-41.75
		4	-3.25	2.50	-14.50
		5	3.25	-6.75	-29.25
		6	4.00	-8.75	-27.25
		7	30.50	4.50	-33.75
		8	-1.00	-8.75	-27.75
		9	12.75	-6.50	-38.75
		10	17.25	2.75	-24.00
		11	18.50	5.50	-12.85
		12	25.00	-5.75	-27.25
	90 sec	1	20.75	15.25	-26.50
		2	9.00	1.75	-29.75
		3	13.00	8.25	-32.50
		4	6.75	2.75	-14.25
		5	16.75	4.00	-34.25
		6	9.75	-14.75	-38.25
		7	11.75	10.00	-43.50
		8	3.50	-5.00	-31.00
		9	19.50	-15.25	-14.75
		10	23.25	2.50	-23.00
		11	29.75	20.25	-20.00
		12	34.00	15.75	-24.75

APPENDIX 3.XXX

AE SCORES OF SUBJECTS IN HORIZONTAL TASK IN EXPERIMENT 3.7

PRESELECTED		SIGHTED Targets(in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	1	1.94	1.72	3.48
	2	2.32	1.82	4.44
	3	1.04	1.48	2.04
	4	1.60	2.38	1.18
	5	0.84	1.42	2.94
	6	1.40	1.62	4.34
	7	0.88	1.10	4.00
	8	1.64	1.50	2.40
	9	1.74	0.54	1.64
	10	0.84	1.48	1.38
	11	0.94	2.64	2.58
	12	1.40	1.98	3.06
	13	1.76	1.46	1.54
	14	0.78	1.16	1.62
	15	0.76	1.44	2.24
	16	0.76	1.08	1.78
	17	1.00	0.70	1.66
	18	0.26	0.92	1.70

Contd..

APPENDIX 3.XXX

AS SCORES OF SUBJECTS IN HORIZONTAL
TASK IN EXPERIMENT 3.Y

PRESELECTED	SIGHTED	Targets(in cm)	
Distractor	Sl.No.	0-15	15-30	30-45
Filled	1	1.94	1.72	3.48
	2	2.32	1.82	4.44
	3	1.04	1.48	2.04
	4	1.60	2.38	1.18
	5	0.84	1.42	2.94
	6	1.40	1.62	4.34
	7	0.88	1.10	4.00
	8	1.64	1.50	2.40
	9	1.74	0.84	1.64
	10	0.84	1.48	1.38
	11	0.94	2.64	2.88
	12	1.40	1.98	3.06
	13	1.76	1.46	1.54
	14	0.78	1.16	1.62
	15	0.76	1.44	2.24
	16	0.76	1.08	1.78
	17	1.00	0.70	1.66
	18	0.86	0.92	1.70

Contd..

APPENDIX 3.XXX (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	1	1.68	1.24	2.92
	2	0.58	1.42	2.40
	3	1.76	1.90	3.04
	4	2.26	3.10	3.14
	5	1.06	1.12	1.56
	6	1.00	1.58	1.70
	7	0.56	0.78	2.34
	8	0.86	0.46	2.36
	9	1.40	2.00	1.42
	10	0.74	0.92	1.62
	11	0.96	2.62	4.04
	12	0.68	2.08	3.02
	13	0.60	1.28	0.64
	14	0.74	0.26	2.04
	15	0.78	1.24	3.08
	16	0.84	1.56	2.10
	17	0.74	1.38	2.06
	18	0.94	1.54	1.16

Contd...

APPENDIX 3.XXX (CONTD.)

Diameter (in cm)				
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	1	1.65	1.24	2.62
	2	0.56	1.42	2.40
	3	1.76	1.20	3.04
	4	2.26	3.10	3.14
	5	1.06	1.12	1.26
	6	1.00	1.02	1.70
	7	0.56	0.72	2.24
	8	0.86	0.42	2.26
	9	1.40	2.00	1.82
	10	0.74	0.52	1.82
	11	0.96	2.62	4.04
	12	0.62	2.08	3.02
	13	0.60	1.22	0.64
	14	0.74	0.46	2.06
	15	0.76	1.24	1.26
	16	0.84	1.26	2.10
	17	0.74	1.32	2.06
	18	0.64	1.24	1.36

Contd...

APPENDIX 3.XXX (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	1	1.38	0.90	2.46
	2	0.86	1.42	2.02
	3	1.40	2.70	4.42
	4	1.68	2.16	3.12
	5	1.50	3.44	3.02
	6	1.24	0.56	1.74
	7	1.38	1.80	1.16
	8	3.42	3.16	1.72
	9	0.88	0.72	2.12
	10	0.90	0.70	0.66
	11	1.20	1.58	2.92
	12	1.66	1.98	2.54
	13	2.92	3.00	1.36
	14	2.16	2.74	1.40
	15	0.90	1.06	1.68
	16	0.80	1.10	2.20
	17	0.80	1.34	2.04
	18	0.94	1.54	2.46

Contd...

APPENDIX 3.XXX (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0.15	15-30	30-45
Filled	19	4.10	3.48	4.16
	20	1.84	3.48	4.94
	21	2.74	3.40	3.18
	22	2.22	3.50	3.94
	23	2.94	2.32	5.00
	24	2.00	3.84	4.22
	25	2.14	4.52	3.12
	26	1.90	3.64	3.74
	27	2.88	3.60	5.26
	28	2.50	3.56	4.12
	29	2.14	3.88	5.36
	30	2.94	3.54	5.86
	31	4.78	3.84	4.42
	32	2.52	3.78	3.96
	33	3.42	2.86	4.42
	34	2.54	3.38	3.92
	35	2.00	2.24	3.65
	36	4.60	3.40	3.44

APPENDIX 3.XXX (CONTD.)

CONSTRAINED		Targets (in cm)	
Distractor	Sl.No.	0.15	15-30
Filled	19	4.10	3.48
	20	3.84	3.48
	21	2.74	3.40
	22	2.22	3.30
	23	2.94	2.32
	24	2.00	3.81
	25	2.14	4.52
	26	1.90	3.64
	27	2.82	3.00
	28	2.50	3.56
	29	2.14	3.88
	30	2.34	3.54
	31	4.78	3.84
	32	2.82	3.78
	33	3.42	2.86
	34	2.54	3.76
	35	2.00	2.54
	36	4.60	3.40

APPENDIX 3.XXX (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	19	1.50	1.88	2.54
	20	0.66	1.38	2.72
	21	1.14	1.88	1.68
	22	1.38	1.08	2.16
	23	1.72	1.82	2.38
	24	2.48	2.18	2.46
	25	1.98	1.50	3.46
	26	1.56	1.68	1.62
	27	0.60	1.10	2.10
	28	1.04	1.62	2.42
	29	0.84	2.20	3.72
	30	0.94	1.64	3.48
	31	0.88	1.38	1.38
	32	1.20	0.90	2.16
	33	1.40	2.20	3.54
	34	1.08	1.52	2.06
	35	1.40	1.54	2.76
	36	1.88	2.72	1.86

Contd...

APPENDIX 3.XXX (CONTD.)

Diameter	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	19	1.50	1.88	2.84
	20	0.66	1.36	2.72
	21	1.14	1.88	1.66
	22	1.38	1.08	3.16
	23	1.72	1.82	2.38
	24	2.48	2.18	2.46
	25	1.98	1.50	3.46
	26	1.86	1.88	1.88
	27	0.60	1.10	2.10
	28	1.04	1.68	2.42
	29	0.84	2.20	3.72
	30	0.94	1.64	3.48
	31	0.88	1.38	1.38
	32	1.20	0.00	2.16
	33	1.40	2.30	3.84
	34	1.08	1.52	2.08
	35	1.40	1.84	2.08
	36	1.88	2.72	1.86

Contd...

APPENDIX 3.XXX (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-14	15-30	30-45
Movement	19	2.18	3.02	4.48
	20	2.24	2.84	3.14
	21	4.20	4.38	4.08
	22	2.44	3.38	4.36
	23	2.72	5.42	3.16
	24	4.06	4.74	1.86
	25	2.82	4.36	3.24
	26	2.58	3.20	4.14
	27	3.00	3.26	3.68
	28	3.14	1.96	5.08
	29	2.52	3.52	4.66
	30	3.44	2.96	5.46
	31	4.68	2.78	3.86
	32	2.00	3.44	3.78
	33	3.96	4.48	3.46
	34	1.68	3.14	3.08
	35	3.00	3.40	3.96
	36	2.76	2.54	3.46

Contd...

APPENDIX 3.XXX (CONTD.)

PRESELECTED		BLIND Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	37	0.98	1.90	2.06
	38	1.24	1.92	1.04
	39	1.66	1.82	3.22
	40	1.70	1.80	2.82
	41	1.62	2.18	4.04
	42	1.10	1.58	3.22
	43	2.40	2.56	3.50
	44	3.00	2.86	3.94
	45	2.18	4.28	4.46
	46	1.62	1.78	3.90
	47	4.08	3.28	4.22
	48	1.44	3.16	3.68
	49	1.92	1.88	3.22
	50	4.24	1.38	2.78
	51	1.30	2.14	3.84
	52	0.82	1.66	2.68
	53	1.40	5.30	1.58
	54	1.14	2.52	2.88

Contd...

APPENDIX 3.XXX (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	37	1.02	0.76	1.12
	38	1.08	0.30	1.80
	39	0.50	0.84	1.32
	40	0.60	0.96	2.42
	41	1.10	1.66	2.22
	42	0.60	1.56	1.30
	43	0.78	1.12	2.02
	44	1.44	1.36	2.90
	45	0.88	1.68	2.66
	46	1.08	1.20	1.80
	47	0.48	1.26	2.06
	48	0.92	0.48	1.66
	49	0.80	1.06	1.48
	50	0.42	1.38	1.64
	51	1.02	1.38	2.08
	52	0.74	0.72	0.68
	53	0.86	1.02	1.74
	54	0.94	0.88	2.32

Contd...

APPENDIX 3.XXX (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	37	1.48	1.52	1.08
	38	1.14	1.62	2.68
	39	1.66	1.90	1.72
	40	1.70	3.26	2.98
	41	1.14	1.80	2.72
	42	2.14	2.88	3.16
	43	2.14	2.78	3.14
	44	2.10	2.18	1.34
	45	1.76	2.48	4.96
	46	2.32	3.22	3.08
	47	3.80	1.94	2.00
	48	1.32	3.74	3.92
	49	1.60	1.80	2.62
	50	0.68	1.74	2.30
	51	1.12	3.86	5.34
	52	1.74	2.54	2.58
	53	2.74	2.38	4.02
	54	1.36	1.94	2.72

Contd...

APPENDIX 3.XXX (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	55	2.18	4.26	2.64
	56	2.96	3.30	3.68
	57	3.74	2.86	3.90
	58	1.42	2.80	3.32
	59	3.04	2.82	4.06
	60	1.96	3.24	3.60
	61	3.16	4.80	5.44
	62	2.84	2.16	3.80
	63	2.90	3.26	6.14
	64	5.04	2.68	6.28
	65	2.78	1.66	4.08
	66	2.68	3.26	4.94
	67	1.52	2.56	6.02
	68	2.58	1.56	3.20
	69	1.40	2.26	5.94
	70	2.40	3.26	1.76
	71	3.70	3.62	4.04
	72	1.70	1.62	1.70

Contd...

APPENDIX 3.XXX (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	55	1.24	1.82	1.84
	56	1.16	1.30	2.58
	57	2.10	1.48	2.80
	58	0.84	1.92	3.78
	59	1.44	1.98	3.00
	60	1.28	2.18	2.94
	61	1.66	1.74	3.10
	62	1.16	0.94	3.28
	63	1.16	2.36	2.44
	64	1.72	2.04	4.60
	65	1.40	1.06	2.58
	66	1.54	1.46	1.36
	67	0.88	1.38	1.22
	68	1.76	0.96	2.04
	69	1.56	1.42	3.08
	70	1.30	0.94	1.78
	71	1.16	1.02	1.94
	72	0.86	0.58	1.16

Contd...

APPENDIX 3.XXX (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	55	1.74	1.72	2.96
	56	3.14	3.44	3.34
	57	2.08	2.20	2.96
	58	1.70	2.52	3.00
	59	2.14	3.36	3.50
	60	2.32	3.14	5.12
	61	3.90	5.12	6.04
	62	2.36	1.34	3.48
	63	1.88	1.84	3.30
	64	3.34	3.52	4.44
	65	2.20	1.46	3.78
	66	2.60	1.68	3.18
	67	1.76	2.28	2.56
	68	2.98	2.88	3.06
	69	2.76	1.80	3.44
	70	2.38	1.24	3.04
	71	3.04	1.98	3.44
	72	2.04	2.12	3.20

APPENDIX 3.XXXI

VE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.7

		SIGHTED		
PRESELECTED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	1	1.90	1.55	1.81
	2	1.25	2.36	5.04
	3	1.29	1.52	2.30
	4	1.84	2.24	1.25
	5	0.77	1.71	1.54
	6	1.26	1.77	2.50
	7	1.01	1.11	3.92
	8	1.95	1.70	1.06
	9	0.73	0.54	1.81
	10	0.85	0.70	1.23
	11	1.00	2.76	2.80
	12	1.52	1.86	2.03
	13	1.53	1.77	1.04
	14	0.83	1.40	1.14
	15	0.53	1.18	1.60
	16	0.69	1.20	1.51
	17	0.48	0.33	0.60
	18	0.17	0.91	1.83

Contd...

APPENDIX 3.XXXI (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	1	1.84	1.10	2.52
	2	0.60	1.55	1.89
	3	1.99	1.20	2.98
	4	1.85	3.76	2.68
	5	1.33	1.07	1.86
	6	0.83	1.83	1.48
	7	0.46	0.88	2.92
	8	1.07	0.58	2.83
	9	1.21	2.41	1.73
	10	0.86	0.77	1.73
	11	1.35	2.88	3.04
	12	0.78	1.80	0.51
	13	0.53	0.48	0.61
	14	0.70	0.29	3.08
	15	0.68	1.63	2.90
	16	0.45	1.79	2.48
	17	0.78	1.70	1.28
	18	0.73	1.24	1.24

Contd...

APPENDIX B.XXXI (CONTD.)

Diatreotor	Sl.No.	Targets (in cm)		
		0-15	15-30	30-45
Drilled	1	1.84	1.10	2.82
	2	0.80	1.86	1.87
	3	1.89	1.80	2.86
	4	1.86	3.76	2.86
	5	1.85	1.07	1.86
	6	0.85	1.83	1.47
	7	0.85	0.88	2.90
	8	1.07	0.82	2.85
	9	1.84	2.11	1.75
	10	0.86	0.77	1.78
	11	1.85	2.88	2.04
	12	0.76	1.80	0.71
	13	0.85	0.48	0.61
	14	0.70	0.29	2.06
	15	0.89	1.83	2.00
	16	0.15	1.75	2.48
	17	0.78	1.70	1.86
	18	0.93	1.84	1.81

Contd...

APPENDIX 3.XXXI (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Movement	1	1.19	1.24	3.18
	2	0.81	1.21	1.46
	3	1.41	3.46	1.06
	4	1.46	2.20	2.35
	5	1.45	4.14	2.92
	6	1.04	0.65	1.88
	7	0.75	2.10	1.36
	8	2.18	4.04	2.22
	9	1.21	0.75	1.56
	10	0.73	0.18	0.64
	11	1.29	1.65	2.68
	12	1.51	1.92	1.99
	13	1.57	2.68	1.53
	14	2.72	1.51	1.10
	15	0.62	1.19	1.19
	16	0.72	1.07	1.94
	17	0.60	0.83	1.83
	18	0.56	1.08	1.48

Contd...

APPENDIX 3.XXXI (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	19	3.36	3.85	3.27
	20	2.16	3.39	4.52
	21	2.55	3.35	3.25
	22	2.12	1.72	4.38
	23	2.92	2.46	5.02
	24	1.64	3.21	3.36
	25	0.73	3.18	3.42
	26	1.90	3.50	0.94
	27	0.28	2.57	5.04
	28	1.34	1.01	1.27
	29	0.37	3.93	1.89
	30	2.96	0.77	3.69
	31	2.16	3.70	4.24
	32	1.38	3.86	2.20
	33	0.99	2.86	0.32
	34	0.91	3.05	3.72
	35	0.70	2.28	3.66
	36	1.45	2.54	2.59

Contd...

APPENDIX 3.XXXI (CONTD.)

CONSTRAINED		Targets (Lb cm)		
Diatractor	Sl.No.	0-15	15-30	30-45
Filled	19	3.36	3.85	3.87
	20	2.16	3.39	4.52
	21	2.85	3.35	3.25
	22	2.12	1.72	4.36
	23	2.92	2.46	3.02
	24	1.64	2.21	3.36
	25	0.73	3.18	3.42
	26	1.90	3.80	0.94
	27	0.28	2.87	2.04
	28	1.34	1.01	1.87
	29	0.37	3.93	1.88
	30	2.96	0.77	3.80
	31	2.16	3.70	4.28
	32	1.38	3.86	2.20
	33	0.99	2.86	0.32
	34	0.91	3.06	3.72
	35	0.70	2.88	3.68
	36	1.45	2.84	2.89

Contd...

APPENDIX 3.XXXI (CONTD.)

Distractor	Sl.No.	Targets (in cm)		
		0-15	15-30	30-45
Unfilled	19	1.65	1.80	0.63
	20	0.71	0.92	3.00
	21	0.45	2.13	2.04
	22	1.32	0.91	2.26
	23	1.66	0.77	2.26
	24	0.59	1.84	1.92
	25	0.68	1.95	2.89
	26	0.65	1.26	1.54
	27	0.69	1.11	1.99
	28	0.87	1.57	1.67
	29	0.86	2.24	0.91
	30	1.11	1.62	2.32
	31	0.77	1.10	1.53
	32	0.93	0.94	1.63
	33	0.41	1.24	2.57
	34	0.29	1.41	1.73
	35	0.47	1.50	1.79
	36	0.41	2.44	1.54

Contd...

APPENDIX 3.XXXI (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	19	0.61	2.99	3.54
	20	1.29	2.43	2.67
	21	1.55	3.83	1.56
	22	2.26	3.33	4.30
	23	1.93	4.12	3.03
	24	1.86	1.47	1.49
	25	0.35	2.67	3.39
	26	2.90	0.78	4.03
	27	1.66	3.21	0.69
	28	0.34	1.60	5.05
	29	2.19	3.00	3.94
	30	0.79	2.54	5.21
	31	1.10	0.66	3.08
	32	1.98	3.38	0.99
	33	1.77	1.12	4.11
	34	0.37	3.20	3.21
	35	0.68	3.44	4.14
	36	0.96	2.72	3.17

Contd...

APPENDIX 3.XXXI (CONTD.)

PRESELECTED		BLIND Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	37	1.18	2.27	2.20
	38	1.01	1.59	1.40
	39	1.17	2.00	3.11
	40	1.13	1.82	1.23
	41	1.10	2.26	3.88
	42	1.34	1.68	1.30
	43	1.22	3.00	1.06
	44	0.77	2.21	0.66
	45	2.19	4.75	1.03
	46	1.55	1.96	5.05
	47	0.80	3.46	4.27
	48	0.56	2.47	4.57
	49	0.84	2.11	3.41
	50	4.54	1.55	1.22
	51	1.17	2.59	2.66
	52	0.51	1.80	2.58
	53	1.17	4.51	1.81
	54	1.32	1.72	1.53

Contd...

APPENDIX 3.XXXI (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	37	0.70	0.66	1.14
	38	1.11	0.40	2.01
	39	0.62	1.19	1.32
	40	0.75	1.01	0.48
	41	0.47	1.78	0.34
	42	0.60	1.64	0.54
	43	0.57	1.21	1.53
	44	1.65	1.49	0.91
	45	0.73	1.39	1.97
	46	0.94	1.29	1.40
	47	0.56	1.41	0.36
	48	1.07	0.58	1.55
	49	1.03	1.42	1.28
	50	0.41	1.35	1.15
	51	1.07	1.38	2.38
	52	0.74	0.89	0.74
	53	0.90	0.40	2.01
	54	1.01	1.07	0.89

Contd...

APPENDIX 3.XXXI (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	37	1.03	1.20	1.12
	38	0.90	1.60	0.48
	39	1.02	1.80	2.10
	40	1.52	3.16	2.23
	41	0.84	1.74	0.50
	42	1.56	2.87	1.85
	43	1.40	2.63	3.14
	44	1.45	2.77	1.32
	45	0.94	2.65	3.45
	46	0.50	3.37	2.24
	47	2.18	2.12	1.59
	48	1.56	3.87	2.05
	49	0.99	1.99	2.49
	50	0.70	1.44	1.74
	51	1.09	2.40	1.54
	52	2.39	2.73	2.46
	53	1.63	2.82	4.07
	54	1.66	2.34	2.93

Contd...

APPENDIX 3.XXXI (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	55	2.25	3.99	0.68
	56	1.87	2.76	3.48
	57	1.60	2.70	3.71
	58	1.61	1.80	2.91
	59	1.07	3.29	4.48
	60	1.70	3.05	2.79
	61	2.06	5.26	1.81
	62	2.31	1.77	1.20
	63	0.75	3.56	2.70
	64	2.45	2.62	2.57
	65	0.44	1.88	2.02
	66	0.70	2.60	3.76
	67	1.71	2.89	5.88
	68	0.86	1.12	0.61
	69	1.37	1.86	2.83
	70	0.89	2.73	1.36
	71	3.00	1.24	3.13
	72	1.48	1.46	1.50

Contd...

Cont'd...

APPENDIX 3.XXXI (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	55	1.24	2.10	1.88
	56	1.21	1.47	0.64
	57	0.30	1.59	0.88
	58	0.87	1.00	0.37
	59	0.73	2.28	1.30
	60	1.28	2.15	0.69
	61	1.08	1.69	2.46
	62	0.77	1.00	1.01
	63	0.55	2.48	2.85
	64	1.18	1.88	1.78
	65	1.13	1.35	1.60
	66	1.39	1.48	0.76
	67	1.16	1.63	1.06
	68	0.90	1.01	2.23
	69	1.76	1.28	2.96
	70	0.68	0.08	1.34
	71	0.54	0.66	1.45
	72	0.77	0.57	1.24

Contd...

APPENDIX 3.XXXI (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	55	1.66	1.84	2.20
	56	0.62	3.26	2.93
	57	1.79	2.26	2.62
	58	1.55	1.56	2.06
	59	0.73	2.97	1.85
	60	0.92	3.36	3.84
	61	1.33	5.66	2.10
	62	0.79	1.21	1.33
	63	1.51	1.56	1.35
	64	2.21	3.74	1.32
	65	0.58	0.77	1.38
	66	0.65	1.79	2.99
	67	1.76	1.07	2.13
	68	0.64	1.30	1.54
	69	1.40	2.29	1.55
	70	0.55	1.61	2.25
	71	1.53	2.04	3.09
	72	0.70	1.12	2.32

Diatractor	Sl.No.	Targets (in cm)		
		0-15	15-30	30-45
Movement	55	1.66	1.84	2.20
	56	0.62	3.25	2.83
	57	1.79	2.38	2.62
	58	1.85	1.89	2.06
	59	0.73	2.37	1.85
	60	0.92	3.36	3.84
	61	1.33	8.66	2.10
	62	0.72	1.21	1.33
	63	1.81	1.86	1.36
	64	2.21	3.74	1.32
	65	0.58	0.77	1.36
	66	0.65	1.73	2.06
	67	1.76	1.07	2.13
	68	0.64	1.30	1.04
	69	1.40	2.39	1.86
	70	0.86	1.81	2.26
	71	1.65	2.04	3.00
	72	0.70	1.12	2.36

APPENDIX 3.XXXII

CE SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.7

		SIGHTED		
PRESELECTED			Targets (in cm)	
Distractor	Sl.No.	0-15	15-30	30-45
Filled	1	0.74	-1.44	-3.48
	2	2.32	0.26	-1.16
	3	0.04	0.20	-1.72
	4	-0.08	-1.18	-0.38
	5	0.76	0.34	-2.94
	6	1.12	-0.22	-4.30
	7	0.48	0.54	-2.56
	8	0.76	0.02	2.40
	9	1.74	0.10	1.56
	10	0.52	1.48	-0.90
	11	-0.06	-1.20	-1.94
	12	-0.04	-0.98	-2.78
	13	1.56	0.22	-1.54
	14	0.62	0.16	-1.62
	15	0.76	-1.08	-1.76
	16	0.60	-0.20	1.62
	17	1.00	0.70	-1.66
	18	0.26	-0.32	0.22

Contd...

APPENDIX 3.XXXII

CS SCORES OF SUBJECTS ON HORIZONTAL TASK
IN EXPERIMENT 3.V

PRESELECTED	SIGHTED		
Distractor	Sl.No.	Targets (in cm)	
		0-15	15-30
Filled	1	0.74	-1.44
	2	2.32	0.26
	3	0.04	0.20
	4	-0.08	-1.18
	5	0.76	0.34
	6	1.12	-0.28
	7	0.48	0.54
	8	0.76	0.02
	9	1.74	0.10
	10	0.52	1.46
	11	-0.06	-1.20
	12	-0.04	-0.08
	13	1.56	0.28
	14	0.62	0.16
	15	0.76	-1.08
	16	0.60	-0.20
	17	1.00	0.70
	18	0.86	-0.32

Contd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	1	-0.36	-1.16	-1.96
	2	0.18	-0.02	-1.60
	3	-0.40	1.90	2.60
	4	-1.70	-3.02	2.86
	5	0.62	0.88	0.04
	6	0.96	0.70	-1.38
	7	-0.56	0.18	0.06
	8	-0.06	-0.22	-0.56
	9	1.40	1.72	0.34
	10	0.46	0.60	-1.06
	11	0.44	-0.62	-2.80
	12	-0.08	-1.12	-3.02
	13	0.44	1.28	-0.64
	14	-0.66	0.06	-0.60
	15	0.46	-0.56	1.40
	16	0.84	-0.26	0.62
	17	0.34	0.68	-1.86
	18	-0.82	-1.54	-0.88

Contd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	1	1.14	0.66	-0.86
	2	0.34	-1.10	-1.54
	3	1.40	-1.58	4.42
	4	1.16	0.20	2.72
	5	0.82	0.44	1.14
	6	1.24	0.56	-1.30
	7	1.38	0.92	0.76
	8	3.42	1.16	0.20
	9	0.08	0.72	2.12
	10	0.66	0.70	0.38
	11	0.68	-0.74	-2.00
	12	1.18	-0.54	-2.02
	13	2.92	1.80	-0.48
	14	0.64	2.74	0.92
	15	0.90	-0.42	-1.36
	16	0.68	0.70	1.20
	17	0.72	1.18	-1.48
	18	0.94	1.34	2.18

Contd...

APPENDIX 3.XXXII (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	19	2.38	-0.04	-3.04
	20	0.36	-2.20	-2.74
	21	1.54	1.04	-1.70
	22	1.94	3.50	1.74
	23	1.98	0.68	1.88
	24	1.48	-2.64	-2.82
	25	2.14	3.44	-0.32
	26	-0.62	1.08	3.74
	27	2.88	2.72	-1.94
	28	2.50	3.56	-4.12
	29	2.14	-0.36	-5.36
	30	0.42	-3.54	-5.06
	31	4.78	1.48	-3.54
	32	2.52	-2.78	-3.96
	33	3.42	1.34	-4.42
	34	2.54	2.02	1.64
	35	2.00	0.08	-0.64
	36	4.60	2.80	2.84

Contd...

APPENDIX 3.XXXII (CONTD.)

CONSTRAINED

District	Sl.No.	Targets (in ...)	
Filled	19	0-15	15-30
	20	2.38	-0.04
	21	0.36	-2.80
	22	1.54	1.04
	23	1.94	3.50
	24	1.58	0.68
	25	1.48	-2.64
	26	2.14	3.44
	27	-0.62	1.08
	28	2.88	2.72
	29	2.80	3.86
	30	2.14	-0.36
	31	0.42	-3.64
	32	4.78	1.48
	33	2.82	-2.78
	34	3.42	1.34
	35	2.54	2.02
	36	2.00	0.08
		4.60	2.80

Contd...

APPENDIX 3.XXXII (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	19	0.26	-0.72	-2.54
	20	0.22	-1.18	0.56
	21	-1.14	0.44	-0.28
	22	-0.54	0.88	-0.04
	23	0.96	-1.82	0.98
	24	2.48	1.78	-1.98
	25	1.98	0.78	-2.22
	26	-1.56	1.20	-1.06
	27	0.00	-0.62	-0.90
	28	0.64	0.42	-1.86
	29	0.04	-0.64	-3.72
	30	0.38	0.48	-2.72
	31	0.88	1.02	-0.30
	32	0.84	-0.62	-1.52
	33	1.40	2.20	-2.90
	34	1.08	-0.92	-1.38
	35	1.40	-0.74	-2.36
	36	1.88	-1.52	-1.34

Contd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15.30	30-45
Movement	19	2.18	-2.02	-3.44
	20	2.24	1.96	-1.70
	21	4.20	2.46	4.08
	22	1.64	1.14	-1.00
	23	2.72	4.10	3.16
	24	4.06	4.74	1.86
	25	2.82	4.16	0.24
	26	0.34	3.20	1.42
	27	3.00	1.06	3.68
	28	3.14	-1.24	-1.12
	29	1.40	-2.08	2.54
	30	3.44	-1.76	-2.02
	31	4.68	-2.78	-2.74
	32	0.60	-1.12	-3.78
	33	3.96	4.48	-0.50
	34	1.68	-1.94	-0.96
	35	3.00	1.36	-0.28
	36	2.76	0.74	1.82

Contd...

APPENDIX 3.XXXII (CONTD.)

		BLIND		
PRESELECTED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	37	0.62	-0.14	0.10
	38	0.84	1.68	0.80
	39	1.66	0.66	-1.02
	40	1.50	0.20	-2.82
	41	1.30	0.14	-1.56
	42	0.42	0.06	-3.22
	43	2.40	-0.28	-3.50
	44	3.00	1.90	-3.94
	45	0.90	1.00	-4.46
	46	0.86	0.38	-1.62
	47	4.08	-1.68	-1.78
	48	1.44	2.16	0.28
	49	1.92	0.00	-2.22
	50	4.24	-0.34	-2.78
	51	-1.10	-1.22	-3.84
	52	-0.82	-0.22	-1.60
	53	0.96	-3.54	-0.86
	54	0.42	-2.36	-2.88

Contd...

APPENDIX 3.XXXII (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Unfilled	37	1.02	0.44	-0.56
	38	0.92	-0.02	-1.00
	39	0.02	0.00	0.56
	40	0.28	0.40	-2.42
	41	1.10	0.78	-2.22
	42	0.04	-0.16	-1.30
	43	0.78	0.04	-1.38
	44	0.40	0.16	-2.90
	45	0.88	1.04	-1.86
	46	0.60	0.40	-1.80
	47	0.08	-0.46	-2.06
	48	0.20	-0.16	-0.98
	49	0.48	-0.06	-1.36
	50	0.42	-0.54	-1.44
	51	0.34	0.70	0.04
	52	0.42	0.16	-0.32
	53	-0.66	-1.02	-0.86
	54	-0.22	0.04	-2.32

Contd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	37	1.02	0.44	-0.56
	38	0.92	-0.02	-1.00
	39	0.02	0.00	0.86
	40	0.28	0.40	-2.42
	41	1.10	0.78	-2.22
	42	0.04	-0.16	-1.30
	43	0.78	0.04	-1.38
	44	0.40	0.16	-2.30
	45	0.88	1.04	-1.86
	46	0.60	0.40	-1.80
	47	0.08	-0.46	-2.06
	48	0.20	-0.16	-0.98
	49	0.48	-0.06	-1.36
	50	0.42	-0.64	-1.44
	51	0.34	0.70	0.04
	52	0.42	0.16	-0.72
	53	-0.66	-1.02	-0.86
	54	-0.28	0.04	-2.22

Contd...

APPENDIX 3.XXXII (CONTD.)

Distractor	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Movement	37	1.40	1.40	-0.56
	38	0.98	0.82	-2.68
	39	1.42	-0.78	-0.44
	40	0.90	-1.02	-2.38
	41	1.14	0.60	-2.72
	42	1.98	-0.72	-2.96
	43	1.94	-2.18	-1.14
	44	1.86	1.54	-0.38
	45	1.76	0.88	-4.32
	46	2.32	-0.10	-2.28
	47	3.80	0.50	-1.40
	48	-0.56	-2.74	-3.92
	49	1.60	-0.08	-1.10
	50	0.44	1.22	-1.90
	51	0.48	-3.46	-5.34
	52	0.30	0.34	-1.22
	53	2.74	0.42	-1.34
	54	0.48	-0.18	-2.32

Contd...

APPENDIX 3.XXXII (CONTD.)

Direction	Sl.No.	Targets (in cm) 0-15	15-30	30-45
Movement	37	1.40	1.40	-0.66
	38	0.98	0.82	-2.08
	39	1.42	-0.78	-0.44
	40	0.90	-1.02	-2.38
	41	1.14	0.60	-2.72
	42	1.08	-0.72	-2.66
	43	1.04	-2.18	-1.14
	44	1.86	1.84	-0.38
	45	1.78	0.88	-1.32
	46	2.32	-0.10	-2.28
	47	3.80	0.30	-1.30
	48	-0.86	-2.74	-3.02
	49	1.60	-0.08	-1.10
	50	0.14	1.22	-1.90
	51	0.58	-3.46	-3.34
	52	0.30	0.34	-1.22
	53	2.74	0.12	-1.34
	54	0.48	-0.18	-2.32

Contd...

APPENDIX 3.XXXII (CONTD.)

CONSTRAINED		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Filled	55	0.94	-2.50	-2.64
	56	2.48	1.94	-1.88
	57	3.74	2.22	-1.66
	58	0.50	-2.80	-2.32
	59	3.04	-0.14	-2.06
	60	1.16	-1.64	-2.80
	61	3.16	-2.68	-5.44
	62	2.04	-1.36	-3.80
	63	2.90	0.10	-6.14
	64	5.04	1.16	-6.28
	65	2.78	0.02	-4.08
	66	2.68	-2.06	-4.38
	67	-0.40	0.04	-4.26
	68	2.58	1.44	-3.20
	69	0.52	2.14	-5.94
	70	2.40	1.98	-1.36
	71	2.50	-3.62	-2.84
	72	1.30	-0.82	1.34

Contd...

APPENDIX 3.XXXII (CONTD.)

CONSTRAINED			
Distractor	Bl.Mol.	0-15	15-30
Pilled	55	0.94	-2.50
	56	2.42	1.94
	57	3.74	2.72
	58	0.80	-2.80
	59	3.04	-0.14
	60	1.16	-1.64
	61	3.16	-2.66
	62	2.04	-1.36
	63	2.30	0.10
	64	3.04	1.16
	65	2.78	0.02
	66	2.58	-2.06
	67	-0.10	0.04
	68	2.58	1.44
	69	0.52	2.14
	70	2.10	1.98
	71	2.30	-3.62
	72	1.30	-0.38

Cont'd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Unfilled	55	0.60	-0.90	0.48
	56	0.16	0.54	-2.58
	57	2.10	0.60	-2.80
	58	0.36	1.92	-3.78
	59	1.44	0.38	-3.00
	60	0.80	-0.54	-2.94
	61	1.34	0.62	-2.10
	62	1.08	0.50	-3.28
	63	1.16	0.40	0.08
	64	1.72	1.16	-4.60
	65	1.28	0.06	-2.38
	66	1.14	-0.30	-1.36
	67	-0.16	-0.38	-1.22
	68	1.76	0.44	-0.52
	69	-0.44	0.82	-1.80
	70	1.30	-0.94	-1.30
	71	1.16	0.86	-1.42
	72	0.58	-0.34	-0.16

Contd...

APPENDIX 3.XXXII (CONTD.)

		Targets (in cm)		
Distractor	Sl.No.	0-15	15-30	30-45
Movement	55	0.70	-0.20	-2.04
	56	3.14	-1.48	-1.74
	57	1.68	0.32	-1.68
	58	1.18	-2.52	-2.60
	59	2.14	2.16	-3.42
	60	2.32	0.86	-3.52
	61	3.90	-0.52	-6.04
	62	2.36	0.70	-3.48
	63	1.64	-1.28	-3.30
	64	3.34	0.12	-4.44
	65	2.20	-1.46	-3.78
	66	2.60	0.76	-2.26
	67	0.72	-2.28	-2.56
	68	2.98	-2.88	-3.06
	69	2.76	0.72	-3.44
	70	2.38	0.12	-3.04
	71	3.04	1.98	-1.84
	72	2.04	-2.12	-2.56

APPENDIX 3.XXXIII

AE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.7

		SIGHTED		
PRESELECTED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	1	3.00	4.20	10.00
	2	2.40	3.80	5.60
	3	4.20	5.20	6.60
	4	3.20	5.00	9.40
	5	5.20	3.00	7.20
	6	3.80	4.40	5.00
	7	1.60	8.20	10.20
	8	2.20	2.80	4.40
	9	6.00	4.80	8.00
	10	4.00	2.80	3.60
	11	1.00	3.80	4.00
	12	4.40	2.80	5.00
	13	5.40	4.80	3.40
	14	2.80	4.40	5.40
	15	3.60	3.00	2.60
	16	3.00	4.60	6.20
	17	5.80	5.80	4.00
	18	1.00	5.00	11.20

Contd..

APPENDIX 3.XXXIII

AE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.7

PURSUIT		SIGHTED	
Instructor	Sl.No.	Targets (in deg.)	
		0-50	50-100
Filled	1	3.00	4.20
	2	2.40	3.80
	3	4.20	5.20
	4	3.20	5.00
	5	5.20	3.00
	6	3.80	4.40
	7	1.60	8.20
	8	2.20	2.80
	9	6.00	4.80
	10	4.00	5.20
	11	1.00	3.80
	12	4.40	2.80
	13	5.40	4.00
	14	2.80	4.40
	15	3.60	3.00
	16	3.00	4.60
	17	5.80	5.80
	18	1.00	5.00

Contd..

APPENDIX 3.XXXIII (CONTD.)

Distractor	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Unfilled	1	2.60	2.00	5.80
	2	2.20	3.60	2.80
	3	3.00	6.40	6.00
	4	3.00	6.20	7.60
	5	2.20	5.60	9.80
	6	4.20	5.40	5.00
	7	2.60	2.40	4.80
	8	5.60	4.40	11.00
	9	5.60	6.40	6.80
	10	2.20	2.60	4.80
	11	0.60	3.20	4.40
	12	2.00	3.80	5.80
	13	3.00	3.20	5.20
	14	3.00	3.80	5.00
	15	3.20	2.60	5.60
	16	1.20	2.80	1.80
	17	3.40	2.20	3.00
	18	2.80	4.60	7.60

Contd...

APPENDIX 3.XXXIII (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	1	2.80	5.60	5.80
	2	4.60	3.20	3.20
	3	4.80	4.00	5.80
	4	5.40	3.80	6.40
	5	2.40	6.00	5.80
	6	4.80	6.00	6.00
	7	2.20	5.40	3.60
	8	6.40	9.40	8.00
	9	4.00	6.00	7.00
	10	2.00	2.60	4.00
	11	1.00	3.00	3.60
	12	2.20	1.80	5.00
	13	3.00	4.60	5.00
	14	6.00	3.20	5.00
	15	6.00	2.00	6.40
	16	3.40	4.60	13.00
	17	7.40	21.60	2.20
	18	5.00	4.20	9.80

Contd...

APPENDIX 3.XXXIII (CONTD.)

CONSTRAINED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	19	2.80	5.80	4.40
	20	3.20	5.00	6.20
	21	2.60	6.80	8.60
	22	7.20	4.80	5.20
	23	2.80	4.80	7.60
	24	2.80	4.60	7.40
	25	6.60	8.00	13.20
	26	10.00	8.40	11.40
	27	9.20	10.60	15.40
	28	11.40	13.40	9.20
	29	6.60	9.40	12.80
	30	8.00	7.60	13.20
	31	9.60	8.00	9.80
	32	7.20	11.60	15.40
	33	13.20	10.60	10.00
	34	7.40	13.80	15.40
	35	8.40	8.60	10.00
	36	6.40	9.80	12.80

Contd...

APPENDIX 3.XXXIII (CONTD.)

Distractor	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Unfilled	19	3.20	1.80	4.40
	20	4.00	5.20	1.40
	21	2.60	3.80	3.20
	22	5.00	3.60	5.60
	23	1.40	5.00	3.60
	24	1.40	6.80	3.60
	25	3.20	5.20	6.40
	26	3.80	5.80	6.40
	27	4.40	5.00	9.60
	28	4.60	3.80	5.00
	29	2.40	4.40	4.40
	30	2.40	5.00	8.20
	31	1.80	6.00	5.60
	32	2.80	5.60	9.20
	33	2.20	5.60	8.00
	34	3.20	5.00	4.60
	35	4.00	4.80	5.00
	36	4.60	5.20	7.00

Contd...

APPENDIX 3.XXXIII (CONTD.)

Distractor	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Movement	19	2.60	4.20	2.40
	20	5.40	8.40	3.60
	21	3.40	5.20	4.60
	22	3.20	5.40	4.60
	23	4.40	3.00	7.00
	24	2.00	5.60	7.60
	25	5.00	9.80	12.20
	26	9.40	12.20	10.40
	27	8.60	10.60	16.20
	28	6.80	7.40	14.80
	29	6.60	8.20	14.80
	30	8.80	8.20	11.40
	31	8.20	10.60	12.80
	32	7.60	9.20	12.60
	33	11.60	6.40	12.40
	34	6.80	6.20	9.00
	35	12.20	7.60	7.60
	36	6.80	9.20	10.80

Contd...

APPENDIX 3.XXXIII (CONTD.)

		BLIND		
PRESELECTED			Targets (in deg.)	
Distractors	Sl.No.	0-50	50-100	100-150
Filled	37	2.40	5.60	9.00
	38	6.40	5.60	12.20
	39	5.20	5.00	12.40
	40	3.80	8.00	13.00
	41	5.00	5.80	12.20
	42	4.00	5.20	5.20
	43	5.60	8.00	8.00
	44	8.20	7.40	7.40
	45	4.00	9.20	9.20
	46	3.00	5.40	5.40
	47	6.40	7.80	7.80
	48	7.40	6.40	7.00
	49	7.60	7.80	6.80
	50	11.20	3.60	3.40
	51	3.60	3.40	4.60
	52	5.20	2.00	6.80
	53	4.60	8.40	6.80
	54	3.40	3.80	6.40

Contd...

APPENDIX 3.XXXIII (CONTD.)

Distractors	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Unfilled	37	2.00	3.00	9.60
	38	1.40	3.40	7.40
	39	3.00	2.00	4.60
	40	0.60	4.00	5.20
	41	0.60	2.40	2.60
	42	1.80	4.20	5.20
	43	1.60	3.40	6.40
	44	2.80	3.20	6.00
	45	2.40	5.20	5.20
	46	1.80	2.80	2.80
	47	3.00	4.20	5.40
	48	4.00	2.40	5.20
	49	4.40	6.60	4.40
	50	5.20	3.40	4.40
	51	1.40	4.20	6.40
	52	2.20	2.40	4.40
	53	2.80	4.60	2.20
	54	2.00	4.40	5.80

Contd...

APPENDIX 3.XXXIII (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	37	3.80	7.20	6.40
	38	3.80	6.20	9.60
	39	6.00	3.20	5.60
	40	5.00	7.40	11.80
	41	1.00	6.20	6.40
	42	6.40	3.80	4.60
	43	3.80	10.80	10.00
	44	3.80	11.40	8.40
	45	1.80	6.40	11.40
	46	4.00	4.20	4.60
	47	3.60	3.40	8.40
	48	5.80	5.00	11.80
	49	7.40	4.80	9.00
	50	8.20	5.60	8.00
	51	4.60	6.00	3.60
	52	3.00	7.00	6.40
	53	5.20	9.60	6.80
	54	3.60	9.00	5.20

Contd...

APPENDIX 3.XXXIII (CONTD.)

CONSTRAINED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	55	6.80	10.00	11.60
	56	9.60	10.00	11.80
	57	5.00	10.60	15.00
	58	5.40	14.20	13.20
	59	6.60	15.00	14.60
	60	2.80	4.60	8.20
	61	7.60	7.80	7.20
	62	7.40	7.00	6.40
	63	6.80	6.80	9.80
	64	3.40	7.00	10.00
	65	8.20	8.80	7.00
	66	6.40	5.40	10.20
	67	6.00	4.60	7.00
	68	9.40	2.20	4.40
	69	4.20	5.20	5.40
	70	5.80	6.20	5.00
	71	5.60	5.20	4.40
	72	7.20	3.20	3.20

Contd...

APPENDIX 3.XXXIII (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	55	3.20	8.20	13.40
	56	3.60	4.60	10.80
	57	5.40	4.80	9.40
	58	5.20	7.40	7.80
	59	2.60	5.80	8.00
	60	3.60	4.60	4.40
	61	5.40	5.80	9.00
	62	5.00	9.60	7.80
	63	4.80	5.80	10.00
	64	4.40	7.20	8.00
	65	9.20	5.60	8.00
	66	5.80	6.20	9.20
	67	2.40	8.20	5.40
	68	4.20	4.60	5.80
	69	4.00	2.80	7.20
	70	5.20	3.40	5.20
	71	4.00	2.40	2.00
	72	2.40	6.40	3.80

Contd...

APPENDIX 3.XXXIII (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	55	8.00	12.40	11.00
	56	6.40	10.00	14.60
	57	7.20	7.40	10.20
	58	5.40	12.40	12.00
	59	3.00	8.40	9.00
	60	5.20	8.60	8.00
	61	4.00	8.00	10.00
	62	3.60	10.40	8.20
	63	7.20	6.80	4.60
	64	6.60	9.60	7.80
	65	11.20	5.20	4.40
	66	9.80	6.40	6.40
	67	8.00	6.80	4.20
	68	8.60	3.00	3.80
	69	5.60	7.60	5.20
	70	5.80	4.20	5.40
	71	7.60	6.40	2.60
	72	4.60	6.00	8.80

APPENDIX 3.XXXIV

VE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.7

PRESELECTED		SIGHTED Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	1	3.31	4.60	4.52
	2	2.65	3.44	4.53
	3	4.07	5.08	7.03
	4	3.54	5.19	2.65
	5	3.31	3.56	7.24
	6	3.98	4.84	5.42
	7	1.94	4.45	7.86
	8	3.26	3.76	5.16
	9	5.71	6.10	8.08
	10	2.68	3.31	1.85
	11	1.33	4.26	3.88
	12	4.69	3.20	5.39
	13	1.02	2.71	4.32
	14	1.47	4.77	6.34
	15	4.05	2.64	3.37
	16	2.76	5.68	7.31
	17	3.93	6.86	4.03
	18	1.55	5.57	11.13

Contd...

Cont'd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	1	3.06	2.64	6.47
	2	0.98	1.96	2.76
	3	3.50	5.87	6.28
	4	3.32	3.31	0.80
	5	2.58	6.47	9.51
	6	5.64	6.37	3.69
	7	2.93	2.56	2.64
	8	3.20	4.96	7.29
	9	6.10	5.31	4.36
	10	2.28	2.87	4.12
	11	0.80	1.47	4.63
	12	2.14	3.49	4.32
	13	0.89	3.26	5.31
	14	3.06	3.93	3.98
	15	2.79	3.31	7.23
	16	1.47	3.12	1.90
	17	2.93	1.85	3.38
	18	2.61	5.38	5.66

Contd...

APPENDIX 3.XXXIV (CONTD.)

Distractor	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Movement	1	3.50	5.76	6.58
	2	4.58	4.10	4.22
	3	5.02	4.45	7.00
	4	5.85	3.90	7.16
	5	2.71	6.42	6.31
	6	4.77	6.59	5.91
	7	0.75	3.63	4.20
	8	5.54	11.20	3.79
	9	4.15	6.57	5.97
	10	2.87	2.86	3.50
	11	1.33	2.94	4.15
	12	2.83	0.98	1.90
	13	2.10	4.96	5.04
	14	5.84	2.76	7.24
	15	5.22	2.48	7.55
	16	2.28	5.03	8.19
	17	3.93	30.62	2.50
	18	4.77	4.58	10.19

Contd...

APPENDIX 3.XXXIV (CONTD.)

CONSTRAINED		Targets (in deg)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	19	1.96	5.53	4.69
	20	5.31	5.34	6.50
	21	3.69	6.50	7.71
	22	3.87	4.35	5.61
	23	3.38	4.71	5.85
	24	1.47	5.42	6.41
	25	2.06	6.24	9.44
	26	10.51	8.82	8.16
	27	7.13	8.94	14.81
	28	10.28	13.00	6.62
	29	1.36	4.63	11.61
	30	5.76	5.68	13.47
	31	7.53	7.86	9.90
	32	1.17	12.61	2.94
	33	4.71	7.14	10.84
	34	5.04	13.94	5.12
	35	1.02	9.13	4.15
	36	2.06	10.93	13.15

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	19	3.26	1.94	3.01
	20	3.12	4.27	1.41
	21	1.02	3.60	3.43
	22	5.85	4.10	5.43
	23	1.10	5.51	2.73
	24	1.50	3.93	4.49
	25	3.31	4.62	4.59
	26	4.54	2.76	7.39
	27	3.44	5.43	6.97
	28	4.75	4.79	6.14
	29	1.36	2.25	2.25
	30	2.93	4.47	7.66
	31	1.94	6.62	6.48
	32	3.31	5.28	7.16
	33	2.99	6.23	6.77
	34	3.58	5.34	4.43
	35	3.29	3.61	6.25
	36	1.02	2.32	7.20

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	19	2.56	4.94	2.65
	20	2.33	8.98	4.47
	21	2.99	6.12	4.92
	22	1.94	5.71	5.11
	23	5.24	2.58	2.28
	24	2.04	6.31	4.18
	25	3.98	3.76	9.13
	26	8.06	12.92	8.23
	27	8.47	10.38	15.32
	28	6.47	7.81	10.46
	29	5.49	8.48	3.31
	30	7.09	7.81	7.80
	31	1.17	9.79	3.71
	32	1.02	9.56	5.31
	33	3.67	4.13	12.19
	34	2.32	1.60	9.28
	35	4.07	6.34	6.40
	36	3.19	7.08	13.16

Contd...

APPENDIX 3.XXXIV (CONTD.)

		BLIND		
PRESELECTED			Targets (in deg)	
Distractor	Sl.No.	0-50	50-100	100-150
Filled	37	2.48	4.50	5.10
	38	6.14	6.37	5.34
	39	2.48	1.90	4.96
	40	3.19	5.54	3.79
	41	3.03	6.37	12.66
	42	3.78	4.17	4.17
	43	6.52	7.05	8.29
	44	7.80	7.44	7.44
	45	3.66	3.06	3.06
	46	1.79	5.40	5.40
	47	1.74	6.50	6.50
	48	7.36	2.94	7.76
	49	4.67	4.82	8.38
	50	3.66	3.61	3.77
	51	3.60	3.74	4.87
	52	4.80	1.62	7.73
	53	2.93	5.16	5.11
	54	2.45	3.90	7.96

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	37	2.80	3.07	2.58
	38	1.36	2.50	7.31
	39	2.93	2.04	4.84
	40	0.80	2.93	1.47
	41	0.80	2.26	2.56
	42	2.06	5.78	6.15
	43	1.94	3.69	1.36
	44	1.72	3.66	5.33
	45	1.85	4.45	3.67
	46	2.15	1.72	2.48
	47	1.67	0.98	1.74
	48	4.67	3.19	3.87
	49	5.12	7.47	5.24
	50	2.04	3.01	4.32
	51	1.96	2.56	3.93
	52	2.48	2.25	4.59
	53	3.03	3.92	2.61
	54	2.15	5.08	5.84

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	37	4.41	7.59	3.14
	38	4.49	7.28	9.89
	39	5.82	3.97	4.12
	40	5.97	1.85	3.97
	41	1.17	5.24	1.36
	42	5.00	3.71	5.39
	43	4.17	8.77	1.79
	44	4.50	9.37	7.99
	45	2.23	6.47	3.44
	46	3.49	3.67	4.59
	47	2.79	4.03	3.01
	48	6.40	5.49	10.89
	49	4.63	6.15	8.88
	50	4.53	6.10	7.27
	51	5.00	6.52	4.13
	52	3.01	3.63	6.71
	53	6.50	4.08	7.23
	54	3.74	8.31	4.17

Contd...

APPENDIX 3.XXXIV (CONTD.)

CONSTRAINED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	55	4.71	1.67	9.52
	56	9.69	10.05	11.59
	57	4.41	2.42	4.77
	58	2.50	10.51	3.43
	59	1.74	6.32	3.44
	60	3.06	3.19	5.84
	61	1.50	8.57	6.59
	62	8.52	7.60	7.34
	63	2.93	7.99	4.79
	64	3.98	4.60	5.37
	65	4.31	9.22	7.71
	66	5.43	4.50	3.49
	67	5.64	5.04	6.86
	68	2.33	0.40	4.80
	69	2.79	3.37	5.60
	70	4.26	5.89	5.08
	71	3.87	6.16	2.68
	72	5.64	3.20	4.21

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	55	2.68	6.47	2.94
	56	3.66	5.38	10.75
	57	3.93	3.03	9.41
	58	6.20	5.38	4.53
	59	2.32	5.95	5.57
	60	3.38	4.84	3.72
	61	5.42	6.39	9.33
	62	5.69	10.09	8.24
	63	4.76	6.25	3.58
	64	5.51	7.18	8.45
	65	6.76	6.66	9.20
	66	5.00	6.92	9.97
	67	1.62	9.26	6.34
	68	3.37	4.53	6.22
	69	1.79	3.01	4.96
	70	1.72	1.62	3.71
	71	4.22	3.19	2.04
	72	2.87	5.57	4.36

Contd...

APPENDIX 3.XXXIV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	55	9.09	9.93	7.13
	56	6.05	2.90	1.50
	57	7.39	5.39	7.49
	58	5.15	9.30	11.79
	59	3.26	8.51	6.44
	60	5.51	3.38	6.85
	61	4.03	8.74	3.63
	62	4.18	11.36	9.58
	63	5.15	5.88	5.37
	64	4.41	9.71	8.19
	65	2.71	4.83	5.89
	66	1.60	7.33	4.72
	67	5.42	8.06	5.24
	68	4.18	3.19	2.33
	69	4.17	5.61	5.53
	70	3.06	3.98	2.58
	71	3.01	6.49	2.65
	72	5.63	6.96	4.62

APPENDIX 3.XXXV

CE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.7

PRESELECTED		SIGHTED Targets (in deg)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	1	-0.20	1.00	-10.00
	2	1.60	-2.60	-5.20
	3	1.80	-2.40	0.20
	4	-1.20	-2.20	-9.40
	5	0.80	0.60	-2.00
	6	1.40	0.40	2.20
	7	-0.80	-8.20	-10.20
	8	-0.60	-1.20	-0.40
	9	3.20	2.00	-1.20
	10	4.00	-0.80	-3.60
	11	0.20	0.20	-1.60
	12	0.00	-0.40	-0.60
	13	5.40	4.80	1.40
	14	2.80	2.00	-2.20
	15	0.00	-2.20	0.20
	16	3.00	1.40	-0.60
	17	5.40	0.60	-3.60
	18	1.00	-1.40	-6.40

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	1	0.20	-1.20	-4.60
	2	2.2	-3.60	-2.00
	3	1.40	-4.00	1.60
	4	-1.40	-6.20	-7.60
	5	0.60	-1.60	-5.00
	6	0.20	1.40	-5.00
	7	-0.20	-0.80	-4.80
	8	-5.60	-1.20	-9.00
	9	2.00	3.60	-5.60
	10	2.20	-0.60	-3.20
	11	0.60	-3.20	-2.40
	12	1.20	-1.80	-4.60
	13	3.00	1.60	-2.80
	14	2.20	1.40	-4.60
	15	-3.20	0.20	0.40
	16	-0.80	-1.20	1.00
	17	2.20	1.40	-0.60
	18	2.00	0.20	-6.00

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	1	0.40	-1.20	-2.20
	2	2.20	0.00	-0.40
	3	0.00	-1.20	-1.40
	4	0.60	1.00	2.00
	5	-0.80	2.00	-0.60
	6	-2.00	-1.60	-5.20
	7	2.20	5.00	-2.00
	8	6.40	1.40	-8.00
	9	0.00	-2.00	-7.00
	10	1.60	0.20	-2.40
	11	0.20	1.40	0.00
	12	1.00	-1.80	-5.00
	13	3.00	0.20	1.80
	14	2.80	2.00	-1.00
	15	6.00	-2.60	-0.40
	16	3.00	19.60	-11.40
	17	7.40	1.80	0.60
	18	5.00	0.00	-3.80

Contd...

APPENDIX 3.XXXV (CONTD.)

CONSTRAINED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	19	2.40	-2.60	-2.00
	20	1.20	1.80	-2.60
	21	1.00	-3.60	4.60
	22	7.20	2.80	0.40
	23	-1.60	2.80	-5.60
	24	2.80	-1.80	-5.40
	25	6.60	5.20	-10.00
	26	-0.80	-2.80	8.20
	27	6.00	6.60	5.00
	28	5.80	6.20	6.80
	29	6.60	-9.40	-6.00
	30	6.00	-5.60	-4.40
	31	6.40	1.6	5.00
	32	7.20	-2.8	-15.40
	33	13.20	8.6	0.40
	34	5.80	2.6	15.40
	35	8.40	3.8	10.00
	36	6.40	-1.80	-4.00

Contd...

APPENDIX 3.XXV (CONTD.)

Distractor	Sl.No.	Targets (in deg.) 0-50	50-100	100-150
Unfilled	19	0.40	-0.20	-4.40
	20	2.80	3.60	-1.00
	21	2.60	1.80	-0.80
	22	1.40	-2.00	-4.40
	23	1.00	1.00	-3.60
	24	0.60	-6.40	-2.80
	25	-1.20	-2.80	-5.60
	26	0.60	5.80	-1.60
	27	-3.60	-1.40	-6.80
	28	-0.20	0.20	1.80
	29	2.40	4.40	4.40
	30	1.20	-3.00	-4.60
	31	1.80	-5.60	-2.00
	32	2.80	-2.40	-6.00
	33	0.20	0.0	-5.60
	34	0.00	-0.2	3.00
	35	4.00	3.6	-1.40
	36	4.60	-5.2	3.40

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	19	1.80	-1.00	-0.40
	20	5.40	-0.40	0.00
	21	2.20	0.40	0.20
	22	3.20	-2.60	-1.80
	23	-2.40	-2.60	-7.00
	24	-1.20	-1.20	-7.60
	25	3.40	-9.80	-8.20
	26	-5.40	-2.20	-6.80
	27	1.80	-2.60	6.60
	28	-2.40	1.80	-11.20
	29	3.80	-1.40	-14.80
	30	5.60	-4.20	-9.00
	31	8.20	-5.40	-12.80
	32	7.60	-3.20	-12.60
	33	11.60	6.40	-7.20
	34	6.80	6.20	-2.20
	35	12.20	5.60	4.80
	36	6.80	-7.20	-2.00

Contd...

APPENDIX 3.XXXV (CONTD.)

PRESELECTED		BLIND Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	37	1.20 ~~12.0~~	-5.60	-9.00
	38	3.20	1.60	-12.20
	39	5.20	-5.00	-12.40
	40	2.20	-6.40	-13.00
	41	5.00	-0.20	-1.80
	42	2.40	-3.20	-3.20
	43	0.80	-4.80	-2.00
	44	5.00	-1.80	-1.80
	45	-2.80	-9.20	-9.20
	46	3.00	1.00	1.00
	47	6.40	-4.60	-4.60
	48	3.40	6.40	-0.20
	49	7.60	7.00	-2.80
	50	11.20	1.60	-0.60
	51	-0.80	-1.00	0.20
	52	2.40	-1.60	0.40
	53	4.20	-8.40	-6.80
	54	3.00	1.00	-0.40

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	37	1.60	-0.60	-9.60
	38	0.60	2.60	1.40
	39	1.80	-0.80	1.40
	40	0.60	-3.20	-5.20
	41	0.60	-1.60	-1.80
	42	-0.60	-3.80	-3.60
	43	1.20	1.00	-6.40
	44	2.80	-1.20	-4.00
	45	-1.60	-2.80	-4.40
	46	-1.40	2.80	2.80
	47	3.00	-4.20	-5.40
	48	2.40	1.20	-4.80
	49	1.60	-2.60	-1.60
	50	5.20	3.40	1.60
	51	0.60	4.20	6.40
	52	6.20	1.60	3.60
	53	0.00	-4.20	-1.00
	54	1.60	3.20	-3.80

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	37	1.40	-4.00	-6.40
	38	-0.20	-0.60	-4.40
	39	3.60	1.20	-5.20
	40	-1.00	-7.40	-11.80
	41	-0.20	-3.40	-6.40
	42	4.40	-1.80	0.60
	43	-1.80	-7.20	-10.00
	44	0.60	-7.40	4.80
	45	-1.80	-1.60	-11.40
	46	2.80	-2.60	-2.60
	47	2.80	-0.60	-8.40
	48	4.20	2.20	-5.80
	49	7.40	0.40	-5.00
	50	8.20	0.00	-6.00
	51	0.20	-2.80	-1.60
	52	2.60	-7.00	2.40
	53	0.40	-9.60	2.40
	54	2.00	-4.60	-4.80

Contd...

APPENDIX 3.XXXV (CONTD.)

CONSTRAINED		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Filled	55	5.20	-10.00	-7.20
	56	3.60	-3.60	-4.60
	57	-2.60	-10.60	-15.00
	58	5.40	-10.20	-13.20
	59	6.60	-15.00	-14.60
	60	-0.80	-3.80	-8.20
	61	7.60	0.60	-6.40
	62	2.60	2.20	2.40
	63	6.80	-2.40	-9.80
	64	2.60	-7.00	-10.00
	65	8.20	0.40	-3.40
	66	5.40	4.60	-10.20
	67	5.20	-1.80	4.60
	68	9.40	-2.20	-2.40
	69	3.80	-5.20	0.20
	70	4.20	-5.40	-1.40
	71	4.80	-2.00	-4.00
	72	5.20	2.40	0.80

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Unfilled	55	2.00	-5.40	-13.40
	56	-0.80	-0.20	-4.00
	57	4.60	4.00	-1.40
	58	-2.00	-5.80	-7.80
	59	1.80	0.20	-6.40
	60	-3.60	-1.40	3.60
	61	1.80	-1.00	-4.20
	62	1.00	-0.40	1.40
	63	3.60	3.40	-10.00
	64	-2.00	-2.00	-2.80
	65	7.20	-4.00	-1.20
	66	3.40	1.40	-1.60
	67	2.40	1.80	-0.60
	68	4.20	-1.80	0.60
	69	4.00	-1.60	-5.60
	70	5.20	-3.40	-5.20
	71	1.60	0.80	-0.80
	72	1.60	-4.40	-0.60

Contd...

APPENDIX 3.XXXV (CONTD.)

		Targets (in deg.)		
Distractor	Sl.No.	0-50	50-100	100-150
Movement	55	-3.60	-8.40	-9.00
	56	2.80	10.00	-14.60
	57	1.60	-5.40	-7.80
	58	3.80	-8.80	-2.80
	59	-0.60	-4.00	-6.60
	60	-2.00	-8.60	-5.20
	61	3.60	2.00	-10.00
	62	-0.40	2.40	-0.20
	63	7.20	-6.80	-1.00
	64	5.40	-2.40	0.60
	65	11.20	2.80	-1.60
	66	9.80	-0.80	-6.40
	67	6.80	-1.20	1.40
	68	8.60	0.20	-3.40
	69	4.80	-5.60	0.40
	70	5.80	-3.40	-5.40
	71	7.60	-5.20	0.60
	72	1.90	-2.20	-8.80

APPENDIX 3.XXXVI

RAW SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.8

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	10	1	0.1	2.2	1.3	0.2	-1.5	2.2
		2	0.7	1.6	2.2	3.5	2.2	2.5
		3	0.7	-0.3	2.4	0.9	-1.1	1.2
		4	0.5	1.0	2.2	1.8	2.1	0.2
		5	0.9	0.0	2.4	1.7	1.2	2.0
		6	0.0	0.0	1.6	-0.2	3.0	1.8
		7	0.3	-0.3	1.0	0.6	-1.2	2.3
	20	1	0.6	1.6	3.2	0.1	-3.3	1.7
		2	-0.5	-2.0	2.6	2.8	2.5	3.3
		3	0.6	-0.5	2.8	-0.9	-0.5	1.7
		4	-1.5	-1.5	0.5	1.0	-0.4	2.5
		5	-0.3	-0.8	1.2	2.2	0.0	2.2
		6	-0.1	-0.3	1.0	-0.5	0.8	2.8
		7	-0.4	-3.0	0.6	-0.3	2.7	2.5
	30	1	2.5	-0.7	2.1	-0.8	-2.4	1.5
		2	0.0	-1.5	2.2	-0.5	-1.5	1.4
		3	-1.0	0.0	0.2	-0.7	-1.8	0.5
		4	-1.5	-1.0	1.5	-2.6	-2.8	3.0
		5	-1.0	-2.3	1.0	0.2	1.6	1.8
		6	-0.4	0.0	0.7	-0.6	2.5	2.3
		7	-1.5	-0.3	1.6	-0.5	1.9	1.3
	40	1	-1.7	-0.3	1.6	-2.3	-2.8	-3.0
		2	-0.2	-0.2	2.0	-1.4	-0.6	-0.5
		3	-2.5	-1.9	-0.5	-0.8	-0.6	1.0
		4	-5.0	-2.5	1.2	-2.1	-0.8	-0.3
		5	-1.5	-3.0	1.4	-2.4	-0.3	0.7
		6	-4.0	-0.3	-0.6	-0.2	-2.8	1.0
		7	2.0	-0.2	1.5	-4.5	-2.3	-3.5

Contd...

APPENDIX A.XXIVI

RAW SCORES OF SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.2

Retention Interval	Targets	Subjects	SIGHTED			UNSIGHTED		
			CMTL	RKMD	FRMD	CMTL	RKMD	FRMD
0 sec	10	1	0.1	8.9	1.3	0.3	-1.8	8.9
		2	0.7	1.8	8.8	8.5	8.2	8.8
		3	0.7	-0.3	2.4	0.9	-1.1	1.8
		4	0.8	1.0	2.8	1.8	8.1	0.8
		5	0.9	0.0	8.4	1.9	1.2	8.0
		6	0.0	0.0	1.6	-0.3	3.6	1.8
		7	0.3	-0.3	1.0	0.6	-1.1	8.3
20		1	0.8	1.0	3.8	0.1	-3.3	1.8
		2	-0.5	-2.0	8.8	8.9	8.0	3.8
		3	0.6	-0.6	2.8	-0.9	-0.8	1.7
		4	-1.8	-1.3	0.3	1.0	-0.4	8.8
		5	-0.3	-0.8	1.8	8.3	0.0	8.8
		6	-0.1	-0.3	1.0	-0.8	0.8	8.8
		7	-0.4	-3.0	0.6	-0.3	8.7	8.3
30		1	8.8	-0.9	8.1	-0.8	-3.4	1.8
		2	0.0	-1.8	8.2	-0.3	-1.8	8.4
		3	-1.0	0.0	0.3	-0.7	-1.8	0.3
		4	-1.8	-3.0	1.3	-2.8	-3.7	8.3
		5	-1.0	-3.3	1.0	0.3	1.8	1.8
		6	-0.4	0.0	0.7	-0.6	8.8	8.3
		7	-1.3	-0.3	1.6	-0.3	1.8	1.3
40		1	-1.7	-0.3	1.6	-2.3	-3.8	-3.0
		2	-0.2	-0.3	2.0	-1.4	-0.8	-0.8
		3	-3.8	-1.0	-0.6	-0.8	0.0	1.0
		4	-3.0	-3.3	1.2	-3.1	-0.8	-0.3
		5	-1.3	-3.0	1.4	-3.4	-0.3	0.7
		6	-4.0	-0.3	-0.6	-0.3	-3.8	1.0
		7	8.0	-0.3	1.3	-4.3	-3.3	-3.3

Cont'd...

APPENDIX 3.XXXVI (CONTD.)

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	RDWD	CNTL	BKWD	FRWD
5 sec	10	1	1.3	1.7	0.3	1.2	-0.2	2.5
		2	1.1	0.0	1.6	2.7	0.0	3.2
		3	0.9	0.0	-0.8	1.6	1.4	1.6
		4	0.5	-0.5	3.5	0.3	2.2	2.3
		5	1.2	1.5	2.0	0.8	2.3	1.3
		6	0.2	-0.3	1.2	0.8	-0.1	1.4
		7	0.5	1.0	1.6	0.8	1.8	0.7
	20	1	1.5	-2.1	-0.4	1.2	1.4	1.2
		2	-1.0	-1.0	1.9	1.4	1.2	2.0
		3	-0.5	-1.1	2.0	1.4	-0.5	2.5
		4	-2.3	-3.0	2.5	-0.8	2.2	0.7
		5	-0.2	-2.2	2.2	2.2	2.0	1.9
		6	-0.2	-0.5	0.5	1.8	1.3	3.2
		7	1.6	-1.5	1.8	1.2	3.2	3.7
	30	1	2.7	0.5	1.2	-1.6	-1.5	0.8
		2	-0.4	-1.0	0.6	1.3	-0.1	0.5
		3	-1.2	0.0	0.6	-1.0	-1.1	0.7
		4	-1.9	-3.1	2.1	-1.6	-3.1	0.2
		5	-0.6	-2.0	0.0	3.0	1.2	2.2
		6	-0.5	-1.9	0.9	-2.9	1.4	3.4
		7	1.6	1.3	1.2	0.6	-0.8	-0.3
	40	1	2.7	-2.2	-0.8	-0.6	-3.6	-3.7
		2	-0.7	-2.5	0.8	-2.6	0.0	0.7
		3	-1.6	-1.5	-0.5	0.6	-1.0	1.8
		4	-3.5	-2.5	0.0	-0.1	-4.5	-4.6
		5	0.0	-2.5	1.8	-2.1	0.6	-0.3
		6	-0.2	-2.6	1.6	2.7	-4.0	1.6
		7	-1.3	-0.6	1.6	2.0	-1.9	-2.6

Contd...

APPENDIX 3.XXXVI (CONTD.)

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND	
			CNTL	RCWD	CNTL	TCWD	FRWD
5 sec	10	1	1.3	1.7	0.3	1.2	-0.2	3.5
		2	1.1	0.0	1.6	2.7	0.0	3.2
		3	0.8	0.0	-0.8	1.6	1.4	1.6
		4	0.6	-0.8	3.6	0.3	2.2	2.3
		5	1.2	1.3	2.0	0.8	2.3	1.3
		6	0.2	-0.3	1.2	0.8	-0.1	1.4
		7	0.6	1.0	1.6	0.8	1.8	0.7
	20	1	1.6	-2.1	-0.4	1.2	1.4	1.2
		2	-1.0	-1.0	1.8	1.4	1.2	2.0
		3	-0.8	-1.1	2.0	1.4	-0.8	2.3
		4	-2.3	-3.0	3.3	-0.8	3.2	0.7
		5	-0.2	-2.8	2.2	0.6	2.0	1.6
		6	-0.2	-0.5	0.8	1.8	1.3	3.2
		7	1.6	-1.3	1.8	1.2	2.2	3.7
	30	1	2.7	0.3	1.2	-1.6	-1.8	0.8
		2	-0.4	-1.0	0.8	1.3	-0.1	0.2
		3	-1.2	0.0	0.2	-1.0	-1.1	0.7
		4	-1.9	-3.1	2.1	-1.6	-3.1	0.2
		5	-0.6	-2.0	0.0	3.0	1.2	2.2
		6	-0.3	-1.2	0.2	-2.9	1.4	3.4
		7	1.6	1.3	1.2	0.6	-0.8	-0.3
	40	1	2.7	-2.2	-0.8	-0.6	-3.6	-3.7
		2	-0.7	-2.5	0.8	-2.6	0.6	0.2
		3	-1.6	-1.3	-0.3	0.6	-1.0	1.2
		4	-3.3	-2.3	0.0	-0.1	-1.3	-4.3
		5	0.0	-2.6	1.2	-2.1	0.2	-0.2
		6	-0.2	-2.6	1.0	2.7	-4.0	1.2
		7	-1.3	-0.6	1.2	2.0	-1.8	-3.2

Contd...

APPENDIX 3.XXXVI (CONTD.)

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
20 sec	10	1	2.8	1.0	1.3	2.3	1.7	2.1
		2	1.0	0.3	2.6	2.0	3.0	1.8
		3	1.5	-0.5	3.6	1.5	2.5	2.2
		4	1.8	1.8	2.8	0.3	1.0	0.4
		5	0.6	-1.0	1.4	1.2	2.3	2.6
		6	0.4	-0.6	2.6	1.8	0.7	1.8
		7	0.8	1.6	1.7	2.1	-0.4	1.2
	20	1	4.2	-0.2	3.0	0.5	-2.4	1.8
		2	1.5	1.5	2.5	3.7	2.5	3.4
		3	1.5	-4.0	3.6	-1.1	-3.0	1.3
		4	1.8	-2.5	5.0	0.0	1.9	2.1
		5	-0.5	-2.3	2.8	3.1	2.8	3.3
		6	-0.5	-2.5	1.5	1.8	4.6	0.5
		7	0.8	-0.8	-1.5	0.9	2.3	1.3
	30	1	4.2	1.6	-0.9	-0.8	-2.7	-1.2
		2	2.4	-2.5	2.0	-2.5	2.5	1.0
		3	-2.4	-2.5	1.6	-0.6	-2.4	2.3
		4	0.7	-3.6	-4.5	-2.6	-0.8	-3.2
		5	-0.5	-2.5	3.6	3.3	-0.7	0.5
		6	-0.8	-1.7	2.5	-1.5	-3.3	1.8
		7	-0.8	-1.5	0.9	-2.5	0.6	-0.3
	40	1	1.7	-3.2	1.7	-2.9	-4.3	-3.8
		2	2.5	-2.0	2.5	-0.5	-5.5	-1.5
		3	3.6	-3.5	3.6	-1.4	-1.8	-4.5
		4	-8.0	-2.0	8.0	-3.0	2.8	-2.2
		5	3.0	-3.5	3.0	0.7	-1.2	1.2
		6	1.0	-3.6	1.0	-1.5	-4.2	-1.4
		7	-3.7	-4.3	2.0	-1.0	-2.6	-0.4

APPENDIX 3.XXXVII

RAW SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.8

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
0 sec	40	1	0	-8	0	1	-6	7
		2	2	-1	-3	2	-3	4
		3	0	-4	12	5	4	13
		4	-1	1	4	7	4	5
		5	-3	-5	2	2	8	9
		6	9	-7	4	0	-2	11
		7	1	-3	8	8	3	15
	50	1	2	-5	10	-2	-4	13
		2	3	-2	7	5	-3	4
		3	0	-7	9	1	6	9
		4	-6	-2	4	5	1	7
		5	-3	-8	-1	0	4	7
		6	-4	-2	10	-1	-2	6
		7	-5	0	3	4	3	8
	130	1	3	-9	-10	-4	-11	12
		2	0	-12	-1	-4	-6	5
		3	-17	8	-5	-2	-8	12
		4	-2	7	-1	7	8	8
		5	-1	-7	8	-4	-3	4
		6	-8	-4	-18	4	10	6
		7	5	-6	-20	-4	-6	9
	140	1	8	-10	1	-6	-15	2
		2	-2	4	17	-3	-4	3
		3	0	2	0	-5	-14	-3
		4	-6	-20	4	-8	-5	-10
		5	5	1	4	-8	-13	-8
		6	8	-5	-5	-8	11	-9
		7	-3	-1	4	-4	-6	0

Contd...

APPENDIX 3.XXXVII (CONTD.)

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
5 sec	40	1	0	-4	0	1	-6	7
		2	3	4	5	6	-3	9
		3	2	5	2	1	4	10
		4	-5	-7	-2	2	-3	11
		5	-4	-7	-4	2	1	4
		6	-5	-2	0	1	1	5
		7	5	7	3	8	4	12
	50	1	-6	-4	-1	2	-6	7
		2	2	8	7	5	-6	8
		3	0	-2	6	-5	6	8
		4	-2	1	0	-4	5	6
		5	-5	-3	2	6	2	12
		6	4	-5	4	4	6	7
		7	2	-5	3	5	6	10
	130	1	7	5	15	-5	-8	3
		2	-2	-10	3	-6	-8	-4
		3	-5	9	6	-2	2	7
		4	1	2	6	-10	8	3
		5	5	2	-1	-7	-4	5
		6	-6	-2	-10	-7	10	1
		7	-1	5	2	5	-7	-3
	140	1	-11	-8	-8	-6	8	5
		2	6	-7	0	-4	5	-3
		3	-1	-3	4	-8	5	6
		4	3	5	2	5	8	-7
		5	6	2	3	-6	2	-8
		6	-9	-5	-8	8	-6	4
		7	8	-11	12	-5	-6	14

Contd...

APPENDIX 3.XXXVII (CONTD.)

Retention Interval	Targets (in cm)	Subjects	SIGHTED			BLIND		
			CNTL	BKWD	FRWD	CNTL	BKWD	FRWD
20 sec	40	1	-8	-11	1	2	-2	6
		2	6	3	6	0	-6	9
		3	2	-3	4	5	7	14
		4	3	-2	3	16	2	7
		5	2	-4	2	4	7	13
		6	2	4	4	14	-1	13
		7	4	-4	6	10	11	15
	50	1	11	-4	3	-5	-7	15
		2	-1	-2	-3	5	-10	9
		3	1	-7	-3	0	6	6
		4	1	-2	-8	6	7	7
		5	-1	-8	-8	4	-8	12
		6	5	2	2	8	-8	4
		7	5	0	-3	4	-3	11
	130	1	-21	-10	9	-14	-11	6
		2	-1	10	4	-7	-8	-4
		3	8	4	4	3	-12	-3
		4	2	4	9	0	7	7
		5	10	2	-15	-3	6	-6
		6	0	-13	-5	-13	-11	7
		7	-8	-10	13	-8	-12	10
	140	1	8	-9	-5	-10	-14	-6
		2	25	-17	9	-7	-13	3
		3	2	6	9	-12	-18	-3
		4	2	4	2	-11	-4	-6
		5	2	-7	1	-10	-1	-4
		6	-10	-11	0	1	8	10
		7	10	-2	10	-12	-14	-11

APPENDIX 3.XXXVIII

AE SCORES OF THE SUBJECTS ON HORIZONTAL TASK IN EXPERIMENT 3.9

PRESELECTED	SIGHTED					
Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	0.48	1.16	0.54	0.74	0.38	1.90
2	0.72	1.78	0.96	1.94	0.76	1.90
3	0.36	1.30	0.82	1.62	0.40	1.18
4	0.32	1.30	0.42	1.56	0.16	1.52
5	0.20	1.26	0.24	0.86	0.20	1.12
6	0.32	1.42	0.38	1.22	0.22	1.94
7	0.30	2.02	0.50	1.72	0.82	1.80
8	0.34	1.86	0.20	1.72	0.30	2.14
9	0.28	1.84	0.24	1.12	0.08	2.50
10	0.40	1.74	0.22	1.46	0.38	1.90
11	0.26	2.34	0.30	1.76	0.28	2.00
12	0.44	1.66	0.48	1.06	0.44	1.52
13	0.40	1.26	0.28	0.98	0.26	1.32
14	0.40	1.50	0.30	1.36	0.30	1.42
15	0.78	1.78	0.82	1.08	0.60	1.36

Contd...

APPENDIX 3.XXXVIII (CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	0.94	1.96	1.42	2.02	1.08	1.96
17	1.72	2.72	1.74	2.54	1.60	2.46
18	1.04	2.08	1.56	2.70	1.96	1.92
19	0.84	1.74	1.26	2.52	0.94	3.60
20	0.84	2.32	1.26	3.38	1.82	3.24
21	0.90	2.02	1.48	1.94	1.10	2.96
22	0.76	2.74	2.46	3.82	2.82	3.06
23	0.92	1.90	1.06	3.00	1.06	3.20
24	0.52	1.80	1.32	2.60	1.66	4.18
25	0.88	1.88	1.52	2.88	1.90	2.56
26	1.06	1.82	1.42	2.08	1.70	3.72
27	1.18	2.52	2.14	3.20	2.08	3.04
28	0.78	2.14	1.80	3.86	2.38	3.08
29	1.32	2.90	3.04	4.18	2.42	4.04
30	1.02	2.22	1.58	3.12	2.16	2.72

Contd...

APPENDIX 3.XXXVIII (CONTD.)

BLIND

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	1.52	1.62	1.72	2.38	1.64	1.74
2	1.46	1.66	1.74	2.84	2.62	2.40
3	1.72	1.48	1.68	5.40	2.14	2.32
4	1.22	2.36	2.42	3.34	2.58	2.14
5	2.20	2.72	1.50	3.76	0.62	3.08
6	0.90	1.96	2.60	2.64	1.40	1.66
7	1.10	0.66	1.08	3.16	1.44	1.42
8	1.68	1.24	1.26	1.36	1.90	1.50
9	1.28	1.52	1.20	1.44	2.48	4.54
10	0.60	2.20	1.74	3.36	1.34	2.56
11	1.74	2.04	2.68	3.56	1.86	2.00
12	0.80	1.80	2.16	1.06	2.00	2.18
13	1.40	2.30	1.34	3.64	2.60	2.10
14	2.00	1.64	2.90	1.88	1.82	2.08
15	1.32	2.68	2.14	2.50	2.22	2.34

Contd...

APPENDIX 3.XXXVIII(CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	1.68	2.14	1.46	2.88	2.42	1.28
17	1.12	3.00	2.18	4.68	2.36	2.50
18	2.32	2.54	1.30	2.28	1.96	2.60
19	1.50	3.24	2.68	1.60	4.02	3.34
20	1.30	1.74	1.92	3.76	1.68	2.90
21	1.96	3.66	1.46	4.42	1.86	2.78
22	1.24	1.92	1.86	3.34	1.40	2.18
23	1.14	1.16	0.90	2.16	2.04	2.00
24	1.04	1.72	1.22	1.42	1.44	1.22
25	1.88	1.88	1.58	1.48	1.64	1.66
26	1.44	1.78	1.02	1.34	3.54	0.98
27	1.42	1.74	3.08	1.54	2.28	2.88
28	1.64	2.66	0.88	4.04	2.14	2.60
29	1.68	2.38	1.98	1.88	1.96	2.38
30	1.26	1.66	1.46	1.78	2.64	2.20

APPENDIX 3.XXXIX

VE SCORES OF THE SUBJECTS ON HORIZONTAL TASK
IN EXPERIMENT 3.9

SIGHTED

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	0.58	1.34	0.56	0.65	0.44	0.52
2	0.78	0.99	0.77	0.31	0.49	1.18
3	0.45	0.64	0.61	1.62	0.42	0.86
4	0.38	1.40	0.38	0.92	0.21	0.69
5	0.19	0.69	0.27	0.96	0.23	1.08
6	0.20	0.98	0.42	1.24	0.31	0.76
7	0.41	0.37	0.38	1.71	0.57	1.83
8	0.37	0.67	0.27	0.72	0.34	0.40
9	0.30	0.71	0.21	1.54	0.10	1.21
10	0.51	0.72	0.25	1.25	0.40	0.64
11	0.33	0.80	0.31	1.78	0.33	1.20
12	0.44	0.61	0.51	0.35	0.55	0.65
13	0.40	0.58	0.20	1.05	0.33	0.64
14	0.52	0.53	0.40	1.01	0.32	0.89
15	0.70	1.25	0.74	0.99	0.34	0.42

Contd...

APPENDIX 5.XXXIX

VS.SCORES OF THE SUBJECTS ON MORAL/MORAL TASK
IN EXPERIMENT 7.9

Subjects	CONTROL		BACKWARD		TWISTED	
	Short	Long	Short	Long	Short	Long
1	0.59	1.34	0.56	0.65	0.44	0.32
2	0.78	0.79	0.77	0.31	0.45	1.10
3	0.45	0.64	0.81	1.62	0.42	0.88
4	0.38	1.40	0.38	0.92	0.21	0.64
5	0.19	0.69	0.27	0.96	0.25	1.08
6	0.20	0.98	0.42	1.24	0.31	0.78
7	0.41	0.37	0.38	1.71	0.57	1.85
8	0.37	0.67	0.27	0.72	0.34	0.40
9	0.30	0.71	0.21	1.54	0.10	1.47
10	0.51	0.72	0.25	1.25	0.40	0.64
11	0.35	0.80	0.31	1.78	0.35	1.20
12	0.44	0.61	0.51	0.35	0.38	0.65
13	0.49	0.58	0.20	1.05	0.33	0.41
14	0.52	0.53	0.40	1.01	0.32	0.89
15	0.70	1.25	0.74	0.59	0.34	0.42

Cont'd...

APPENDIX 3.XXXIX (CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	0.97	0.81	0.48	0.69	0.89	0.81
17	1.69	0.84	0.50	0.57	0.86	1.23
18	1.06	1.04	0.30	0.51	0.60	0.34
19	0.91	0.42	0.29	1.16	0.17	0.92
20	0.80	0.51	0.29	1.67	0.66	0.85
21	0.25	1.57	0.25	0.59	0.24	1.00
22	0.84	0.71	0.15	0.92	0.18	0.63
23	0.95	1.34	0.94	1.03	0.32	0.74
24	0.54	0.66	0.35	1.00	0.66	0.88
25	0.94	1.34	0.60	2.46	0.27	1.85
26	1.02	0.57	0.22	0.86	0.49	0.69
27	1.24	0.87	0.84	0.82	1.50	0.55
28	0.82	0.68	0.49	0.40	1.69	0.93
29	1.22	0.83	0.62	0.98	0.68	0.75
30	1.01	0.56	0.28	0.94	0.50	0.66

Contd...

APPENDIX 3.XXXIX (CONTD.)

BLIND

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	1.44	1.70	1.71	1.50	0.41	1.75
2	1.48	0.83	1.72	2.94	2.11	0.58
3	0.90	1.45	1.75	7.69	0.69	2.29
4	1.30	2.38	2.28	2.97	1.49	1.76
5	2.50	3.01	1.54	0.28	0.87	3.26
6	0.97	2.17	2.54	3.11	3.63	1.77
7	1.27	0.70	1.02	4.18	1.35	1.59
8	1.03	1.34	1.31	1.04	2.02	1.25
9	1.24	1.74	1.34	1.24	1.61	5.61
10	0.71	2.25	1.92	2.10	1.16	2.47
11	1.89	1.78	1.85	3.14	1.78	1.89
12	0.69	2.31	2.04	1.18	0.37	2.25
13	1.28	2.13	1.41	1.13	0.45	2.04
14	1.72	1.75	2.91	2.22	2.67	1.52
15	1.50	1.19	2.53	3.31	1.47	1.65

Contd...

APPENDIX 5.XXXIX (CONTD.)

PRESELECTED

BLIND

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	1.44	1.70	1.71	1.50	0.41	1.75
2	1.48	0.89	1.72	2.94	2.11	0.58
3	0.90	1.45	1.75	7.69	0.89	2.29
4	1.30	2.38	2.28	2.97	1.43	1.76
5	2.50	3.01	1.54	0.28	0.87	3.26
6	0.97	2.17	2.54	3.11	4.89	1.77
7	1.27	0.70	1.02	4.16	1.33	1.59
8	1.03	1.34	1.31	1.04	2.02	1.25
9	1.24	1.74	1.34	1.24	1.61	5.81
10	0.71	2.25	1.92	2.10	1.16	4.47
11	1.89	1.75	1.85	3.14	1.78	1.98
12	0.69	2.31	2.04	1.18	0.37	2.25
13	1.28	2.13	1.41	1.13	0.45	2.04
14	1.72	1.75	2.31	2.22	2.67	1.32
15	1.30	1.19	2.13	3.31	1.47	1.89

Contd...

APPENDIX 3.XXXIX (CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	1.84	1.84	1.50	0.54	0.93	0.63
17	1.08	1.87	2.40	1.60	2.35	1.71
18	2.58	2.48	1.22	1.57	1.57	0.79
19	1.31	3.13	3.32	1.98	2.52	3.10
20	1.55	1.94	1.31	1.94	1.33	3.36
21	0.85	3.17	1.94	4.82	1.22	2.54
22	1.26	2.14	0.85	1.88	0.49	2.06
23	1.19	1.19	0.67	1.35	0.80	1.11
24	0.57	1.55	1.44	1.07	0.74	0.44
25	0.63	1.82	1.74	1.01	1.73	1.73
26	1.18	1.69	0.61	1.32	2.10	1.10
27	0.38	1.66	1.97	1.51	1.58	2.75
28	1.11	2.17	1.19	1.76	2.18	0.83
29	1.86	2.27	2.17	1.75	2.14	1.03
30	0.48	1.57	0.89	2.10	2.00	1.44

APPENDIX 3.XXXX

CE SCORES OF THE SUBJECTS ON HORIZONTAL TASK
IN EXPERIMENT 3.9

SIGHTED

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	0.04	-0.12	0.34	-0.54	-0.22	-1.90
2	-0.16	-1.78	0.64	-1.94	0.68	-1.74
3	-0.16	-1.30	0.62	0.26	0.12	-0.90
4	-0.12	-0.30	0.38	-1.40	-0.04	-1.52
5	0.20	-1.26	0.08	-0.34	0.00	-0.48
6	-0.32	-1.22	-0.14	-0.50	-0.02	-1.94
7	-0.18	-2.02	-0.34	-0.80	-0.74	-0.24
8	-0.06	-1.86	0.04	-1.72	-0.14	-2.14
9	-0.08	-1.84	0.20	-0.16	0.04	-2.50
10	0.00	-1.74	0.10	-0.90	-0.02	-1.90
11	-0.06	-2.34	-0.14	-0.72	-0.08	-2.00
12	-0.36	-1.66	0.20	-1.06	-0.24	-1.52
13	0.20	-1.26	0.28	-0.14	-0.06	-1.32
14	0.00	-1.50	0.06	-0.96	-0.06	-1.30
15	0.58	-1.78	0.50	-0.64	0.60	-1.36

Contd...

APPENDIX 3.XXXX

GR SCORES OF THE SUBJECTS ON NONSENSICAL TASK
IN EXPERIMENT 3.9

Subjects	CONTROL		SUGGESTED		TOWARD	
	Short	Long	Short	Long	Short	Long
1	0.04	-0.12	0.34	-0.34	-0.22	-1.30
2	-0.16	-1.78	0.64	-1.34	0.68	-1.74
3	-0.16	-1.30	0.62	0.26	0.12	-0.90
4	-0.12	-0.30	0.38	-1.30	-0.04	-1.32
5	0.20	-1.26	0.08	-0.74	0.20	-0.88
6	-0.32	-1.22	-0.14	-0.30	-0.02	-1.96
7	-0.18	-2.02	-0.34	-0.80	-0.74	-0.24
8	-0.06	-1.86	0.04	-1.72	-0.14	-2.14
9	-0.08	-1.84	0.20	-0.16	0.04	-2.30
10	0.00	-1.74	0.10	-0.30	-0.22	-1.30
11	-0.06	-2.34	-0.14	-0.72	-0.06	-2.40
12	-0.36	-1.66	0.20	-1.06	-0.24	-1.32
13	0.20	-1.26	0.38	-0.14	-0.06	-1.32
14	0.00	-1.30	0.06	-0.36	-0.06	-1.30
15	0.38	-1.78	0.30	-0.84	0.80	-1.36

Cont'd...

APPENDIX 3.XXXX(CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	0.14	-1.96	-1.42	-2.02	0.76	1.96
17	0.52	-2.72	-1.74	-2.54	1.60	2.46
18	0.20	-2.08	-1.56	-2.70	1.96	1.92
19	0.04	-1.74	-1.26	-2.52	0.94	3.60
20	0.36	-2.32	-1.26	-3.38	1.82	3.24
21	0.90	-1.42	-1.48	-1.94	1.10	2.96
22	0.16	-2.74	-2.46	-3.82	1.94	3.06
23	0.00	-1.54	-0.58	-3.00	1.06	3.20
24	0.24	-1.80	-1.32	-2.60	1.66	4.18
25	-0.12	-1.48	-1.52	-1.52	1.90	1.96
26	0.62	-1.82	-1.42	-3.08	1.70	3.72
27	-0.10	-2.52	-2.14	-3.20	1.56	3.04
28	-0.10	-2.14	-1.80	-3.86	2.06	3.08
29	-0.68	-2.90	-3.04	-4.18	2.42	4.04
30	0.22	-2.22	-1.58	-3.12	2.16	2.72

Contd...

APPENDIX 3.XXXX (CONTD.)

BLIND

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
1	1.32	0.20	1.08	-1.98	1.64	0.90
2	-0.46	-1.66	0.90	-0.84	1.78	2.40
3	-1.72	-0.72	-0.56	-5.08	2.14	-1.12
4	0.30	-1.02	-1.10	-1.70	2.59	1.22
5	0.20	-1.20	-0.86	-3.36	0.22	-1.64
6	0.66	0.72	-0.80	0.00	1.08	-0.62
7	-0.14	-0.18	0.56	1.68	0.84	1.18
8	1.68	-0.24	0.86	0.96	-0.22	-1.50
9	1.20	0.12	-0.36	-1.24	2.40	-0.14
10	-0.32	-1.40	0.14	-3.08	-1.26	-1.32
11	0.34	-1.72	-2.28	-3.16	1.06	-0.88
12	0.60	-1.40	-0.92	-0.18	2.00	0.62
13	1.16	-1.50	-0.14	-3.64	2.60	1.30
14	1.20	-0.84	-1.90	0.28	0.98	1.68
15	0.92	-2.68	-0.94	-1.86	-2.22	-1.94

Contd ....

APPENDIX 3.XXXX (CONTD.)

CONSTRAINED

Subjects	CONTROL		BACKWARD		FORWARD	
	Short	Long	Short	Long	Short	Long
16	0.84	-1.78	-0.54	-2.88	2.42	1.28
17	0.44	-2.60	-0.06	-4.68	0.84	-2.06
18	0.80	-1.30	-0.66	-1.92	1.56	2.60
19	1.46	-1.64	0.12	-0.52	3.54	-1.50
20	0.34	-0.94	-1.80	-3.76	1.68	0.62
21	1.96	-2.26	0.26	-1.26	1.66	1.98
22	-0.44	-0.24	1.86	-3.34	1.40	-1.14
23	1.14	-1.04	-0.66	-2.04	2.04	1.88
24	1.04	-1.08	-0.74	-1.14	1.44	1.22
25	1.88	-0.84	0.38	-1.24	0.00	0.50
26	1.44	1.14	-1.02	0.54	3.46	-0.10
27	1.42	-1.02	-1.12	0.70	2.04	1.28
28	1.56	-2.14	0.04	-4.04	1.34	2.60
29	0.24	-1.18	-0.54	-1.08	0.52	2.38
30	1.26	-1.02	1.38	0.22	2.08	2.08

APPENDIX 3.XXXXI

AE SCORES OF SUBJECTS ON CURVILINEAR TASK IN EXPERIMENT 3.9

SIGHTED

PRESELECTED

Subjects	CONTROL		BACKWARD		FORWARD	
	Targets (in degrees)					
	60-90	90-120	60-90	90-120	60-90	90-120
1	1.80	3.80	0.80	3.20	1.80	2.60
2	5.00	2.40	3.20	3.80	1.00	2.60
3	2.40	4.60	1.20	4.40	0.40	2.20
4	1.00	3.00	2.00	3.40	0.80	1.60
5	1.80	3.40	1.00	3.60	1.00	3.60
6	1.20	4.20	2.20	3.80	1.60	3.60
7	1.20	3.60	2.00	3.60	1.40	3.80
8	1.60	2.20	1.40	2.80	1.60	3.80
9	0.80	3.20	0.80	3.40	2.60	4.60
10	1.80	3.20	1.60	4.80	1.80	3.40
11	1.00	3.80	1.60	3.40	0.60	3.20
12	1.20	4.00	1.60	4.00	2.00	2.60
13	1.60	3.20	1.20	3.40	1.20	4.20
14	1.00	3.80	1.20	2.40	1.40	3.60
15	1.40	4.40	1.20	4.80	1.80	4.40

Contd....

APPENDIX 3.XXXXI (CONTD.)

SIGHTED

CONSTRAINED

Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60–90	90–120	60–90	90–120	60–90	90–120
16	5.80	6.20	6.80	8.60	5.80	11.60
17	6.80	7.20	10.20	11.20	7.60	9.40
18	6.00	6.20	9.20	11.20	8.20	11.60
19	5.20	6.80	10.40	10.20	9.60	10.60
20	5.20	7.60	11.20	13.00	7.80	11.40
21	3.60	6.20	7.20	10.60	8.20	10.00
22	4.80	7.00	8.60	12.00	8.40	11.40
23	4.00	7.40	8.20	9.20	7.60	12.40
24	1.80	5.80	6.80	7.80	9.00	14.00
25	4.80	6.80	9.20	10.00	10.40	11.60
26	3.60	6.00	8.60	10.60	8.60	12.40
27	4.20	5.60	7.00	9.60	10.00	10.60
28	4.20	5.80	8.20	10.40	8.20	12.20
29	5.20	7.00	8.60	9.80	10.20	10.80
30	4.00	7.60	9.00	11.40	8.20	12.60

Contd...

APPENDIX 3.XXXXI (CONTD.)

PRESELECTED — BLIND

Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
1	2.40	4.20	13.00	8.60	8.60	6.00
2	3.40	3.00	7.20	13.40	5.60	11.20
3	2.80	5.60	10.00	7.40	7.40	10.80
4	5.00	4.40	4.20	3.20	4.80	4.20
5	3.80	4.40	3.60	16.00	4.40	5.00
6	6.20	5.60	8.40	7.40	9.40	2.80
7	3.20	4.80	6.60	5.20	6.20	4.40
8	2.20	2.60	6.60	7.80	4.60	5.20
9	5.60	6.20	4.20	8.00	8.00	6.00
10	4.80	1.40	5.80	2.80	3.20	4.80
11	3.80	2.80	6.00	11.00	6.60	8.80
12	3.00	2.80	5.60	7.20	7.20	3.20
13	4.20	3.00	4.40	4.40	4.20	9.60
14	2.00	5.60	6.00	7.00	1.20	6.00
15	3.00	4.40	4.40	3.20	2.80	5.00

Contd...

APPENDIX 3.XXXXI (CONTD.)

CONSTRAINED	BLIND					
Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60–90	90–120	60–90	90–120	60–90	90–120
16	13.60	3.60	9.00	9.00	8.00	6.60
17	5.60	15.00	14.60	3.60	6.80	13.40
18	6.20	5.20	6.00	9.00	10.~~3~~0	8.40
19	~~8~~.00	7.80	5.60	9.40	9.80	16.60
20	5.00	5.40	9.80	10.60	7.00	8.00
21	8.60	5.80	8.80	2.20	10.20	5.60
22	8.00	9.00	7.00	5.00	4.60	7.00
23	3.80	6.20	5.80	5.60	1.80	10.20
24	9.40	8.00	11.00	6.40	7.40	4.60
25	4.00	3.80	4.20	11.20	6.20	6.40
26	5.20	5.80	4.60	4.00	4.60	7.40
27	6.60	5.80	12.20	5.20	5.40	4.00
28	5.60	9.20	7.00	14.80	5.20	7.80
29	9.60	7.40	7.60	14.80	7.80	5.20
30	3.60	7.20	6.60	3.60	5.80	9.60

Contd...

APPENDIX 3.XXXXII

VE SCORES OF SUBJECTS ON CURVILINEAR TASK
IN EXPERIMENT 3.9

PRESELECTED	SIGHTED					
	CONTROL		BACKWARD		FORWARD	
Subjects	Targets (in degree)					
	60-90	90-120	60-90	90-120	60-90	90-120
1	1.62	3.25	0.75	1.94	1.60	2.48
2	0.89	2.64	3.03	4.02	1.36	3.26
3	2.19	3.19	1.50	4.63	0.80	2.56
4	1.02	1.79	2.19	3.25	1.02	1.72
5	1.60	3.19	1.47	2.25	1.02	3.31
6	1.62	1.72	2.33	3.61	1.36	2.93
7	1.41	1.02	2.14	3.35	1.96	2.83
8	1.02	2.45	1.36	2.10	1.90	1.72
9	1.10	2.56	1.26	2.65	4.21	3.72
10	2.14	1.17	1.02	2.48	2.61	2.15
11	1.17	1.60	1.47	1.85	0.75	2.61
12	1.17	4.16	1.60	4.34	2.14	3.32
13	1.72	2.32	1.17	3.29	0.98	3.97
14	1.10	2.87	1.36	1.36	1.20	4.13
15	1.41	2.42	0.75	1.60	2.23	4.03

Contd...

APPENDIX 3.XXXXII (CONTD.)

CONSTRAINED	SIGHTED					
	CONTROL		BACKWARD		FORWARD	
	Targets (in degree)					
Subjects	60-90	90-120	60-90	90-120	60-90	90-120
16	2.04	6.14	1.94	1.50	1.47	2.94
17	6.27	2.23	2.93	2.93	1.62	2.65
18	6.05	5.80	1.94	2.71	1.72	2.94
19	3.74	4.96	3.07	2.99	1.10	1.02
20	4.22	1.96	2.79	2.37	1.72	2.73
21	3.16	5.38	1.47	2.65	1.33	2.45
22	3.72	1.67	3.26	1.90	1.02	2.25
23	4.27	7.36	1.33	2.48	1.36	3.20
24	1.90	5.85	6.94	2.71	0.89	3.52
25	4.12	1.47	1.60	3.10	2.42	2.87
26	3.63	6.28	1.36	1.74	1.50	8.75
27	1.17	6.23	0.63	2.42	2.09	3.50
28	4.36	5.35	1.17	2.58	1.72	2.71
29	5.46	2.00	1.02	7.47	2.64	1.17
30	4.24	5.02	1.26	2.25	1.94	3.56

Contd...

APPENDIX 3.XXXXII (CONTD.)

BLIND

PRESELECTED

Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
1	3.14	3.01	7.16	6.50	2.58	2.76
2	3.87	3.50	3.87	12.09	3.61	2.79
3	3.54	4.71	8.32	6.74	6.26	10.53
4	3.37	3.67	4.12	3.72	2.79	5.27
5	4.54	2.73	4.45	4.69	6.63	4.62
6	7.55	5.60	5.43	8.69	10.33	1.94
7	2.32	4.45	8.71	3.54	7.03	5.46
8	1.26	2.73	6.12	8.57	3.31	5.71
9	5.50	6.15	5.37	8.94	8.28	6.52
10	2.14	1.96	5.31	4.15	3.92	6.26
11	2.87	3.54	6.40	4.34	5.91	4.79
12	2.65	2.94	4.26	3.66	4.79	3.97
13	5.00	3.46	4.62	4.05	4.87	6.85
14	2.60	5.16	5.49	7.92	1.47	6.78
15	3.60	2.06	4.50	3.76	1.60	4.31

Contd...

APPENDIX 3.XXXXII (CONTD.)

BLIND:

CONSTRAINED

Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
16	7.09	2.48	8.71	3.03	7.81	7.81
17	1.36	2.45	5.16	4.18	3.43	9.95
18	5.64	3.61	1.67	10.81	10.37	8.91
19	8.89	7.09	5.20	8.74	7.68	16.04
20	3.16	7.09	3.87	4.18	3.03	1.79
21	5.85	3.87	9.06	2.32	3.31	6.79
22	5.31	9.54	5.44	6.09	5.81	6.49
23	3.37	6.89	6.55	5.08	2.06	9.78
24	7.73	5.08	4.24	7.00	8.11	5.00
25	5.11	4.43	4.34	10.78	6.92	6.43
26	6.65	6.74	5.46	3.87	3.72	4.88
27	6.56	7.22	4.49	5.78	5.16	3.43
28	3.13	9.95	7.39	14.39	6.77	8.39
29	10.14	8.11	3.61	14.39	8.45	4.41
30	3.44	5.00	5.00	4.53	4.94	2.25

APPENDIX 3.XXXXIII

CE SCORES OF SUBJECTS ON CURVILINEAR TASK
IN EXPERIMENT 3.9

PRESELECTED	SIGHTED					
Subjects	CONTROL		BACKWARD		FORWARD	
	Targets (in degree)					
	60–90	90–120	60–90	90–120	60–90	90–120
1	-1.40	-2.2	-0.80	-3.20	-1.80	-2.20
2	-5.50	-1.2	-2.00	-0.20	0.60	-0.60
3	-2.00	-3.8	0.40	-0.40	0.40	0.20
4	-0.60	-3.0	0.00	-1.80	-0.40	1.20
5	-1.80	-2.2	0.20	-3.60	-0.60	-2.80
6	0.40	-4.2	-0.60	-2.60	-1.60	-2.80
7	0.00	-3.6	-0.80	-2.00	-0.60	-3.00
8	-1.60	-1.0	-1.40	-2.00	0.00	-3.80
9	0.00	-2.80	0.00	-2.60	1.80	-3.40
10	0.20	-3.20	1.60	-4.80	-1.00	-3.40
11	0.20	-3.80	-1.20	-3.40	0.20	-2.00
12	-1.20	0.80	-1.20	0.00	-1.20	-0.60
13	-1.20	-2.80	-0.80	-1.00	-1.20	-2.20
14	-1.00	-3.40	-0.40	-2.40	-1.40	-0.40
15	-1.00	-4.40	-1.20	-4.80	-0.20	-2.40

Contd...

APPENDIX 3.XXXVIII

CZ SCORES OF SUBJECTS ON CURVILINEAR TASK
IN EXPERIMENT 3.9

Subjects	CONTROL		EXCITED		NORMAL	
	Targets (in degrees)					
	60-90	90-120	60-90	90-120	60-90	90-120
1	-1.40	-5.2	-0.80	-3.20	-1.80	-5.20
2	-5.30	-1.2	-5.00	-0.20	0.00	-0.80
3	-2.00	-3.8	0.40	-0.40	0.40	0.20
4	-0.60	-3.0	0.00	-1.80	-0.40	1.20
5	-1.80	-5.2	0.30	-3.60	-0.60	-5.80
6	0.40	-1.2	-0.60	-2.60	-1.60	-2.80
7	0.00	-3.6	-0.80	-2.00	-0.00	-3.00
8	-1.60	-1.0	-1.40	-2.00	0.00	-3.80
9	0.00	-2.80	0.00	-2.60	1.80	-3.40
10	0.20	-3.20	1.60	-1.30	-1.00	-3.40
11	0.20	-3.80	-1.20	-3.40	0.20	-6.00
12	-1.20	0.60	-1.80	0.00	-1.20	-0.80
13	-1.20	-2.80	-0.80	-1.00	-1.20	-2.20
14	-1.00	-3.40	-0.40	-2.10	-1.40	-0.40
15	-1.00	-1.40	-1.20	-1.80	-0.20	-2.80

Contd...

APPENDIX 3.XXXXIII (CONTD.)

SIGHTED

CONSTRAINED

Subjects	CONTROL		BACKWARD Targets(in degree)		FORWARD	
	60–90	90–120	60–90	90–120	60–90	90–120
16	-5.80	2.20	-6.80	-8.60	5.80	11.60
17	-3.20	-7.20	-10.20	-11.20	7.60	9.40
18	0.80	-3.00	-9.20	-11.20	8.20	11.60
19	-4.00	-5.20	-10.40	-10.20	9.00	10.60
20	-3.60	-7.60	-11.20	-13.00	7.80	11.40
21	-2.00	-3.80	-7.20	-10.60	8.20	10.00
22	-3.60	-7.00	-8.60	-12.00	8.40	11.40
23	-1.60	-1.80	-8.20	-9.20	7.60	12.40
24	-1.00	-1.40	-1.20	-7.80	9.00	14.00
25	-2.80	-6.80	-9.20	-10.00	10.40	11.60
26	-2.00	0.40	-8.60	-10.60	8.60	9.20
27	-4.20	-2.40	-7.00	-9.60	10.00	10.60
28	0.60	-3.40	-8.20	-10.40	8.20	12.20
29	-0.40	-7.00	-8.60	-6.60	10.20	10.80
30	0.00	-6.00	-9.00	-11.40	8.20	12.60

Contd...

APPENDIX 3.XXXXIII (CONTD.)

BLIND :

PRESELECTED

Subjects	CONTROL		BACKWARD Targets (in degree)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
1	-0.40	-3.40	-13.00	-7.40	8.60	6.00
2	-0.20	0.60	-7.20	-9.80	5.60	11.20
3	-0.80	-3.20	-6.00	-4.60	5.00	6.00
4	-4.20	-4.40	-4.20	-2.40	4.80	-2.20
5	-0.60	-4.40	-1.20	-16.00	4.00	-3.80
6	-2.20	-1.20	-7.60	-3.00	-1.40	2.80
7	-3.20	-3.20	-3.40	-4.80	0.60	-0.40
8	-1.40	-1.40	-5.40	-4.20	3.80	-3.20
9	-2.40	-1.40	1.00	-7.60	4.80	1.20
10	-4.80	-1.40	-5.40	0.00	-1.20	0.00
11	-3.40	-0.80	-5.20	-11.00	-4.20	-8.80
12	-2.60	-1.60	-2.80	-7.20	-7.20	-4.20
13	-0.20	-1.00	0.08	4.00	2.20	7.20
14	-2.00	-4.40	-2.80	-5.00	1.20	0.00
15	0.20	-4.40	1.60	-1.20	-2.80	-3.80

Contd...

APPENDIX 3.XXXXIII (CONTD.)

Subjects	CONTROL		BACKWARD Targets (in degrees)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
1	-0.40	-3.40	-13.00	-7.40	8.00	8.00
2	-0.20	0.60	-7.20	-9.80	5.60	11.20
3	-0.80	-3.20	-6.00	-4.80	5.00	6.00
4	-4.20	-4.40	-44.20	-5.40	4.80	-4.20
5	-0.60	-4.40	-1.20	-16.00	4.00	-3.80
6	-2.20	-1.20	-7.60	-3.00	-1.40	2.80
7	-3.20	-3.20	-3.40	-4.80	0.60	-0.40
8	-1.40	-1.40	-5.40	-4.20	3.80	-3.20
9	-2.40	-1.40	1.00	-7.60	4.80	1.20
10	-4.80	-1.40	-5.40	0.00	-1.20	0.00
11	-3.40	-0.80	-5.20	-11.00	-4.20	-8.80
12	-2.60	-1.80	-2.80	-7.20	-7.20	-4.20
13	-0.20	-1.00	0.00	4.00	2.20	7.20
14	-2.00	-4.40	-2.80	-5.00	1.20	0.00
15	0.20	-4.40	1.60	-1.20	-2.80	-3.80

Contd...

APPENDIX 3.XXXXIII(CONTD.)

BLIND

CONSTRAINED

Subjects	CONTROL		BACKWARD Targets (in degree)		FORWARD	
	60-90	90-120	60-90	90-120	60-90	90-120
16	-13.60	-3.20	-2.60	-9.00	5.60	-0.60
17	5.60	-15.00	-14.60	-1.60	6.80	9.40
18	-4.20	4.40	-6.00	-2.20	4.40	-0.40
19	-1.60	-5.40	3.60	-7.00	9.80	-8.20
20	5.00	-1.80	9.80	-10.60	7.00	-8.00
21	-9.60	-5.80	-2.80	-0.20	-10.20	-0.80
22	-6.80	0.60	-7.00	-4.60	0.20	5.80
23	-2.20	-0.60	-0.20	-5.60	-0.60	- 5.00
24	-7.40	-6.80	-11.00	-1.60	-1.40	-0.60
25	-1.20	1.00	-3.00	-4.40	1.40	4.80
26	0.40	0.60	0.60	-3.20	4.60	7.40
27	-4.60	-0.20	-12.20	-1.60	2.60	3.20
28	-5.60	-3.80	-2.60	-7.20	0.40	-3.00
29	-4.00	-1.80	-7.60	-7.20	-3.80	4.40
30	-2.40	7.20	6.60	2.80	5.00	9.60

4.1

APPENDIX 4.I

RAW SCORES OF SUBJECTS IN EXPERIMENT 4.1

SIGHTED

DISTRACTORS

Subjects	Unfilled Delay		Verbal Distractor		Tactual Distractor	
	Retention intervals in sec.		Retention intervals in sec.		Retention intervals in sec..	
	5	30	5	30	5	30
1	1.40	2.13	1.53	1.43	2.08	2.38
2	1.43	1.45	1.35	1.40	0.93	2.05
3	2.38	3.80	2.28	2.70	2.68	4.38
4	1.33	2.28	1.65	1.63	1.78	2.28
5	2.70	3.18	1.20	1.88	1.63	2.13
6	2.88	4.90	3.40	3.80	2.10	4.55
7	2.90	2.73	4.53	3.20	3.58	3.65
8	1.23	1.73	1.60	1.50	2.10	1.53
9	3.00	4.85	2.60	3.18	3.50	4.40
10	2.13	3.13	2.13	4.50	3.95	3.20
11	2.83	2.90	4.75	3.70	3.75	8.30
12	1.65	2.28	1.28	1.53	1.73	2.45
13	2.90	6.53	8.05	4.35	2.28	5.20
14	2.08	4.05	3.48	3.65	3.83	3.73
15	1.93	3.93	2.08	1.60	4.15	2.43
16	3.30	3.85	2.05	2.50	2.43	3.98

Contd....

4.2 APPENDIX 4.I (CONTD.)

BLIND

DISTRACTORS

Subject	Unfilled Delay		Verbal Distractor		Tactual Distractor	
	Retention intervals in sec.		Retention intervals in sec		Retention intervals in sec.	
	5	30	5	30	5	30
17	3.95	4.25	2.10	5.20	5.30	3.08
18	2.18	3.90	2.08	2.68	2.30	5.08
19	5.30	6.45	4.40	4.10	7.78	5.73
20	1.95	2.83	2.05	3.03	2.95	3.88
21	1.78	2.90	2.08	2.30	5.78	5.53
22	1.90	1.95	1.85	1.78	2.00	2.30
23	3.48	4.58	2.38	3.03	2.95	4.73
24	3.58	1.68	1.78	1.33	4.13	7.58
25	1.33	3.60	2.13	2.08	1.53	1.78
26	2.88	1.93	2.65	2.70	4.08	2.68
27	1.58	2.05	1.68	1.50	2.13	2.85
28	2.83	4.38	1.68	3.13	1.68	5.45
29	1.85	2.88	1.78	1.88	2.10	4.53
30	3.78	4.35	3.65	3.40	3.33	6.68
31	1.95	2.30	1.73	2.28	2.00	2.28
32	2.00	2.75	1.88	3.98	3.35	4.95

4.3

APPENDIX 4.II

RAW SCORES OF SUBJECTS IN EXPERIMENT 4.2

ADULTS

SIGHTED

Unfilled Delay

Subjects	Retention intervals in sec.		
	5		30
1	2.06	9	3.40
2	2.28	10	3.10
3	2.11	11	2.68
4	2.31	12	3.82
5	1.68	13	2.79
6	2.76	14	3.24
7	2.32	15	2.51
8	1.71	16	2.46

Verbal Distractor

	Retention intervals in sec.		
	5		30
17	1.79	25	3.44
18	3.03	26	3.64
19	2.96	27	1.88
20	3.68	28	2.77
21	2.92	29	2.80
22	3.93	30	2.81
23	2.58	31	3.19
24	1.74	32	3.93

Contd.....

4.4 APPENDIX 4.II (CONTD:)

Tactual Distractor

Subjects	Retention intervals in sec		
	5		30
33	2.66	41	2.35
34	2.76	42	2.56
35	2.13	43	5.05
36	2.84	44	1.90
37	2.80	45	3.34
38	2.08	46	3.41
39	2.97	47	2.76
40	1.45	48	3.39

ADULTS

BLIND

Unfilled Delay

Subjects	Retention intervals in sec		
	5		30
49	2.65	57	2.00
50	2.68	58	2.75
51	2.23	59	2.46
52	2.40	60	2.48
53	2.97	61	3.09
54	3.26	62	4.39
55	2.68	63	4.63
56	2.06	64	2.91

Contd....

APPENDIX 4.II (CONTD.)

Verbal Distractor

Subjects	Retention intervals in sec.		
	5		30
65	2.07	73	2.32
66	1.74	74	1.66
67	1.70	75	2.65
68	1.81	76	1.90
69	2.16	77	2.79
70	1.97	78	2.40
71	2.29	79	2.62
72	1.79	80	2.92

Tactual Distractor

Subjects	Retention intervals in sec.		
	3		30
81	2.41	89	3.45
82	3.50	90	6.04
83	3.24	91	2.68
84	4.86	92	5.19
85	6.81	93	3.65
86	2.43	94	3.71
87	3.97	95	3.31
88	3.86	96	3.44

Contd.....

4.6

APPENDIX 4.II (CONTD.)

CHILDREN

SIGHTED

Unfilled Delay

Subjects	Retention intervals in sec.		
	5		30
97	1.60	104	1.92
98	1.67	105	1.82
99	2.94	106	2.60
100	2.71	107	3.48
101	2.00	108	3.23
102	1.52	109	2.21
103	1.81	110	2.82

Verbal Distractor

Subjects	Retention intervals in sec.		
	5		30
111	2.36	118	2.03
112	3.05	119	2.05
113	2.12	120	1.55
114	1.77	121	2.14
115	1.91	122	1.91
116	1.58	123	3.44
117	1.56	124	2.00

Contd.....

4.7

APPENDIX 4.II (CONTD.)

Tactual Distractor

Subjects	Retention intervals in sec.		
	5	30	
125	2.64	132	3,56
126	2.04	133	2.71
127	2.41	134	2.50
128	1.41	135	3.03
129	2.74	136	2.06
130	3.12	137	2.95
131	2.68	138	2.55

CHILDREN

BLIND

Unfilled Delay

Subjects	Retention intervals in sec.		
	5	30	
139	1.86	144	3.24
140	2.40	145	4.90
141	3.16	146	2.94
142	2.01	147	3.26
143	3.10	148	3.13

Contd.....

APPENDIX 4.II (CONTD.)

Verbal Distractor

Subjects	Retention intervals in sec.		
	5		30
149	1.79	154	3,92
150	2.01	155	4.18
151	2.40	156	3.54
152	2.42	157	3.05
153	2.48	158	2.84

Tactual Distractor

Subjects	Retention intervals in sec.		
	5		30
159	4.33	162	2.98
160	2.85	163	5.42
161	2.02	164	4.33
		165	3.60
		166	2.68

APPENDIX 4.III

RAW SCORES OF SUBJECTS FOR EXPERIMENT 4.3

SIGHTED

Verbal Distractor

Subjects	Retention intervals in sec.				
	00	02	05	10	30
1	2.90	3.25	2.50	2.95	3.05
2	2.00	2.40	2.75	1.70	2.55
3	3.75	2.55	2.90	4.30	4.75
4	2.40	1.60	2.00	1.70	2.00
5	1.95	2.15	1.90	3.00	2.30
6	3.00	3.50	2.00	3.00	3.05
7	2.75	1.65	2.22	1.70	2.25
8	3.35	2.65	2.55	4.50	2.90
9	1.15	2.80	2.95	1.70	2.20
10	1.00	2.75	1.25	1.00	1.35
11	1.15	2.75	1.55	2.55	1.75
12	3.65	2.40	2.55	2.80	2.25
13	1.80	1.50	1.05	2.50	1.15
14	2.00	2.45	2.00	2.20	2.55
15	2.85	2.55	2.60	2.15	4.40
16	2.00	1.80	2.10	2.20	2.50
17	2.75	2.30	2.70	2.30	2.00
18	1.45	1.55	1.35	2.35	2.75
19	4.00	2.25	2.00	3.70	2.10
20	2.55	1.75	1.55	2.35	1.80

Contd.....

APPENDIX 4.III (CONTD.)

SIGHTED

Tactual Distractor

Subjects	Retention intervals in sec.				
	00	02	05	10	30
21	2.00	6.00	2.30	3.55	2.55
22	1.55	1.30	3.05	2.95	3.50
23	2.75	2.65	1.75	2.05	3.00
24	2.35	1.95	3.00	4.90	3.05
25	2.45	2.50	3.05	1.30	2.35
26	2.55	2.65	2.75	2.20	3.30
27	2.05	2.60	1.70	2.55	2.15
28	2.65	3.00	3.50	1.75	3.05
29	3.25	4.50	2.45	2.80	2.50
30	2.20	1.85	4.10	4.55	1.60
31	1.40	2.30	1.25	1.65	1.90
32	2.10	2.05	2.00	2.25	1.95
33	3.70	3.75	2.70	3.00	2.50
34	3.35	2.05	1.65	2.05	2.00
35	3.40	3.55	2.25	2.60	3.30
36	1.30	2.00	1.25	2.45	3.05
37	2.20	2.25	1.40	1.90	2.05
38	2.25	2.60	2.50	1.90	3.25
39	3.75	2.25	2.25	2.45	2.05
40	1.75	1.40	1.60	1.60	2.15

Contd.....

APPENDIX 4.III (CONTD.)

BLIND

Verbal Distractor

Subjects	Retention intervals in sec.				
	00	02	05	10	30
1	0.75	1.10	1.45	1.60	2.45
2	1.90	1.40	2.40	2.15	3.00
3	1.65	1.70	1.90	2.05	1.85
4	1.20	2.20	1.75	1.55	2.15
5	1.05	1.10	1.15	1.40	1.50
6	1.65	1.60	1.60	2.15	2.80
7	1.70	1.30	1.75	1.90	1.55
8	1.80	2.05	2.10	2.35	2.75
9	1.85	1.45	1.35	2.85	1.55
10	1.55	1.40	2.60	2.95	2.50
11	1.65	1.95	1.75	1.85	2.85
12	1.45	1.35	1.85	2.40	4.00
13	1.20	1.45	2.40	2.80	3.55
14	1.10	1.35	2.15	1.90	2.75
15	1.65	1.60	1.85	2.30	3.05
16	1.30	1.55	1.75	1.80	1.85
17	1.80	1.85	2.10	2.50	3.90
18	1.65	1.40	1.15	2.20	3.55
19	1.10	1.65	1.75	1.65	3.80
20	0.85	1.50	1.15	1.70	1.75

Contd.....

APPENDIX 4.III (CONTD.)

BLIND

Tactual Distractor

Subjects	Retention intervals in sec.				
	00	02	05	10	30
21	1.85	1.60	1.65	2.75	5.15
22	2.60	2.05	2.60	3.30	4.25
23	1.45	2.30	2.75	2.60	3.45
24	1.55	1.85	3.25	4.20	2.75
25	1.60	2.15	2.95	2.90	5.25
26	1.15	2.20	2.75	2.80	3.70
27	1.50	2.45	2.25	3.70	4.75
28	1.15	1.95	1.80	3.20	3.30
29	2.30	2.65	2.70	4.35	5.00
30	1.95	2.25	2.00	2.45	3.25
31	1.20	1.75	2.85	2.25	4.20
32	1.55	1.40	2.25	3.50	4.50
33	1.50	1.70	2.45	3.60	3.30
34	1.05	1.35	1.65	3.20	3.30
35	1.80	2.05	3.00	3.15	4.70
36	1.55	1.90	2.05	3.00	3.50
37	1.95	1.60	3.10	2.80	3.55
38	2.30	1.95	2.90	4.15	3.00
39	1.40	1.25	2.05	3.75	3.30
40	1.10	2.00	2.10	5.50	5.25

APPENDIX 4.IV

AE SCORES OF SUBJECTS IN EXPERIMENT 4.4

SIGHTED

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Subjects	Short Sector	Subjects	Long Sector	Subjects	Short Sector	Subjects	Long Sector
1	0.30	6	0.30	11	0.14	16	1.20
2	0.32	7	0.90	12	0.38	17	0.46
3	0.28	8	0.66	13	0.20	18	0.92
4	0.34	9	0.74	14	0.24	19	0.40
5	0.10	10	1.84	15	0.40		

Constrained

KINESTHETIC				TACTUAL-KINESTHETIC			
Subjects	Short Sector	Subjects	Long Sector	Subjects	Short Sector	Subjects	Long Sector
20	0.56	25	1.38	28	0.64	33	0.86
21	0.28	26	0.66	29	0.60	34	0.54
22	0.62	27	0.98	30	0.30	35	0.72
23	0.42			31	0.34	36	0.50
24	0.66			32	0.64		

Contd....

APPENDIX 4.IV (CONTD.)

BLIND

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
37	0.46	42	0.68	47	0.22	52	0.80
38	0.18	43	0.92	48	0.18	53	0.42
39	0.28	44	0.64	49	0.18	54	0.34
40	0.18	45	0.44	50	0.34	55	0.68
41	0.32	46	0.96	51	0.12	56	0.84

Constrained

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
57	0.72	61	0.68	66	0.40	71	0.42
58	0.16	62	0.80	67	0.84	72	0.60
59	0.50	63	0.36	68	0.36	73	0.76
60	0.52	64	0.92	69	0.80	74	0.64
		65	0.92	70	0.52	75	0.52

Contd.....

APPENDIX 4.IV (CONTD.)

CE SCORES OF SUBJECTS IN EXPERIMENT 4.4

SIGHTED

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
1	0.20	6	-0.22	11	0.06	16	-1.02
2	0.32	7	0.90	12	-0.34	17	-0.46
3	0.28	8	0.22	13	-0.20	18	-0.92
4	0.34	9	0.10	14	0.24	19	-0.40
5	0.10	10	1.84	15	0.16		

Constrained

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
20	0.24	25	1.06	28	0.64	33	0.86
21	0.20	26	0.66	29	0.60	34	0.30
22	0.46	27	0.94	30	0.30	35	0.72
23	0.42			31	0.26	36	0.50
24	0.66			32	0.64		

Contd.....

4.16

APPENDIX 4.IV (CONTD.)

BLIND

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
37	0.42	42	-0.68	47	0.18	52	-0.72
38	0.10	43	0.52	48	0.04	53	0.02
39	0.28	44	0.64	49	-0.02	54	0.34
40	0.06	45	0.04	50	0.30	55	0.40
41	-0.32	46	0.16	51	0.00	56	-0.64

Constrained

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
57	0.08	61	0.48	66	0.36	71	-0.26
58	-0.12	62	0.80	67	0.84	72	0.16
59	0.14	63	0.16	68	0.24	73	-0.76
60	0.28	64	-0.32	69	0.80	74	0.08
		65	0.92	70	0.52	75	0.28

Contd.....

APPENDIX 4.IV (CONTD.)

MOVEMENT TIME SCORES OF SUBJECTS IN EXPERIMENT 4.4

SIGHTED

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long Sector
1	3.00	6.	9.28	11	3.30	16	3.72
2	1.86	7	3.10	12	3.66	17	3.04
3	3.02	8	2.88	13	1.58	18	4.38
4	1.52	9	5.20	14	2.10	19	2.66
5	2.64	10	2.32	15	2.16		

Constrained

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long-Sector
20	1.24	25	3.58	28	1.50	33	4.36
21	1.92	26	7.22	29	1.84	34	3.22
22	3.52	27	2.10	30	2.00	35	3.40
23	0.92			31	3.84	36	7.24
24	1.70			32	1.92		

Contd.....

APPENDIX 4.IV (CONTD.)

BLIND

Preselected

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long Sector
37	1.40	42	1.78	47	2.00	52	2.14
38	1.26	43	1.52	48	1.36	53	2.74
39	1.12	44	2.84	49	2.02	54	2.76
40	2.10	45	3.24	50	2.12	55	4.70
41	2.18	46	1.58	51	1.38	56	5.66

Constrained

KINESTHETIC				TACTILE-KINESTHETIC			
Sub-jects	Short-Sector	Sub-jects	Long-Sector	Sub-jects	Short-Sector	Sub-jects	Long Sector
57	2.92	61	4.24	66	2.38	71	3.52
58	2.66	62	2.28	67	1.86	72	2.42
59	2.66	63	1.90	68	1.46	73	3.00
60	2.16	64	2.40	69	1.56	74	1.98
		65	2.06	70	1.56	75	3.90

APPENDIX 4.V

SCORES OF SUBJECTS IN EXPERIMENT 4.5

SIGHTED

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-strained	Sub-jects	Prese-lected	Sub-jects	Con-strained
1	0.28	6	0.38	11	0.52	16	1.06
2	0.12	7	0.34	12	0.36	17	0.82
3	0.32	8	0.40	13	0.30	18	1.32
4	0.38	9	0.42	14	0.58	19	0.90
5	0.14	10	0.30	15	0.36	20	1.00

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-sttained	Sub-jects	Prese-lected	Sub-jects	Con-strained
21	0.22	26	0.46	31	0.64	35	0.82
22	0.42	27	0.50	32	0.78	36	0.84
23	0.16	28	0.56	33	0.58	37	1.26
24	0.32	29	0.64	34	1.34	38	0.96
25	0.44	30	0.28			39	2.28

Contd.....

APPENDIX 4.V (CONTD.)

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-strained	Sub-jects	Prese-lected	Sub-jects	Con-strained
40	0.44	44	1.30	48	0.42	52	0.46
41	0.28	45	0.46	49	0.30	53	0.76
42	0.24	46	0.34	50	1.08	54	0.78
43	0.46	47	0.32	51	0.42	55	0.34
						56	0.96

BLIND

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-strained	Sub-jects	Prese-lected	Sub-jects	Con-strained
57	0.48	61	0.58	66	0.66	71	1.14
58	0.56	62	0.32	67	1.18	72	0.98
59	0.38	63	0.30	68	0.84	73	0.74
60	0.20	64	0.18	69	0.46	74	1.30
		65	0.64	70	0.42	75	0.62

Contd.....

APPENDIX 4.V (CONTD.)

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-strained	Sub-jects	Prese-lected	Sub-jects	Con-strained
76	0.38	81	0.40	85	0.50	90	0.62
77	0.28	82	0.50	86	0.90	91	1.24
78	0.28	83	0.18	87	0.80	92	0.66
79	0.26	84	0.52	88	1.02	93	0.30
80	0.34	8		89	0.50		

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG SECTOR			
Sub-jects	Prese-lected	Sub-jects	Con-strained	Sub-jects	Prese-lected	Sub-jects	Con-strained
94	0.42	99	0.32	104	0.50	108	1.24
95	0.24	100	0.90	105	0.26	109	0.78
96	0.10	101	0.30	106	1.02	110	0.98
97	0.30	102	0.36	107	0.98	111	0.60
98	0.24	103	0.46				

Contd....

APPENDIX 4.V (CONTD.)

BLIND

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
57	0.48	61	0.58	66	0.66	71	1.14
58	0.56	62	0.32	67	1.18	72	0.98
59	0.38	63	0.30	68	0.84	73	0.74
60	0.20	64	0.18	69	0.46	74	1.30
		65	0.64	70	0.42	75	0.62

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
76	0.38	81	0.40	85	0.50	90	0.62
77	0.28	82	0.50	86	0.90	91	1.24
78	0.28	83	0.18	87	0.80	92	0.66
79	0.26	84	0.52	88	1.02	93	0.30
80	0.34			89	0.50		

Contd.....

APPENDIX 4.V (CONTD.)

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
94	0.42	99	0.32	104	0.50	108	1.24
95	0.24	100	0.90	105	0.26	109	0.78
96	0.10	101	0.30	106	1.02	110	0.98
97	0.30	102	0.36	107	0.98	111	0.60
98	0.24	103	0.46				

CE SCORES OF SUBJECTS IN EXPERIMENT 4.5

SIGHTED

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
1	0.16	6	0.10	11	-0.28	16	-0.46
2	0.12	7	0.30	12	-0.36	17	-0.42
3	0.32	8	-0.20	13	0.02	18	1.08
4	0.26	9	0.30	14	-0.46	19	0.58
5	-0.14	10	0.26	15	-0.28	20	0.44

Contd.....

APPENDIX 4.V (CONTD.)

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
21	-0.22	26	0.26	31	-1.54	35	-0.82
22	0.10	27	0.06	32	0.16	36	0.48
23	-0.08	28	0.48	33	-0.54	37	0.70
24	-0.32	29	-0.24	34	-0.02	38	0.48
25	0.32	30	-0.08			39	2.12

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
40	0.28	44	1.14	48	-0.42	52	-0.14
41	-0.24	45	0.02	49	-0.06	53	-0.24
42	0.12	46	0.18	50	-1.08	54	-0.66
43	0.10	47	0.24	51	-0.30	55	0.14
						56	-0.88

Contd.....

APPENTIX 4.V (CONTD.)

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
94	0.42	99	0.32	104	-0.26	108	0.92
95	0.04	100	0.86	105	-0.26	109	0.78
96	-0.10	101	0.18	106	-0.18	110	0.98
97	-0.30	102	0.24	107	0.10	111	-0.00
98	-0.04	103	0.42				

MOVEMENT TIME SCORES OF SUBJECTS IN EXPERIMENT 4.5

SIGHTED

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
1	3.62	6	2.30	11	4.22	16	4.88
2	1.84	7	2.00	12	4.52	17	4.48
3	3.18	8	1.84	13	8.62	18	1.92
4	2.22	9	3.10	14	4.52	19	5.56
5	1.38	10	3.06	15	4.14	20	3.88

Contd.....

APPENDIX 4.V (CONTD.)

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
21	3.84	26	2.92	31	4.58	35	5.78
22	1.46	27	2.04	32	7.02	36	6.36
23	1.54	28	3.60	33	11.00	37	4.96
24	4.54	29	1.46	34	6.56	38	10.00
25	2.74	30	1.88			39	5.14

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
40	8.84	44	3.84	48	3.62	52	6.32
41	3.76	45	2.84	49	1.82	53	3.74
42	1.84	46	4.48	50	4.24	54	3.46
43	1.36	47	5.92	51	4.64	55	6.76
						56	9.02

Contd.....

APPENDIX 4.V (CONTD.)

BLIND

Unfilled Delay

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
57	7.40	61	1.46	66	4.74	71	2.84
58	2.04	62	1.24	67	3.92	72	9.30
59	1.38	63	1.22	68	2.60	73	2.18
60	1.18	64	1.56	69	1.88	74	5.54
		65	1.68	70	6.44	75	3.62

Verbal Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
76	3.00	81	3.18	85	6.72	90	4.56
77	1.08	82	1.40	86	6.44	91	7.62
78	1.08	83	2.94	87	1.98	92	3.72
79	1.68	84	1.42	88	6.42	93	7.36
80	2.00			89	3.08		

Contd.....

APPENDIX 4.V (CONTD.)

Tactile-Kinesthetic Distractor

SHORT-SECTOR				LONG-SECTOR			
Sub-jects	Pre-selected	Sub-jects	Con-strained	Sub-jects	Pre-selected	Sub-jects	Con-strained
94	1.84	99	3.70	104	1.88	108	2.52
95	2.34	100	1.40	105	1.58	109	2.48
96	0.88	101	2.36	106	2.78	110	5.04
97	2.88	102	2.76	107	6.10	111	2.52
98	2.36	103	1.12				

5.1

APPENDIX 5.I

STIMULUS MATERIAL USED IN EXPERIMENTS 5.1 AND 5.2

ONE ROW

HLC	WFC	QTM	GSB	SPM	ZHJ
TND	FDR	XKR	VZK	PHB	RXT
RPK	LDS	DXN	LJS	CJM	KHF
MZR	SVF	GLC	BKR	NTV	MZB
HGN	KNH	RVT	KJC	CNP	LRT

XJS GNC

TWO ROWS

KHC	TZR	JVS	FTM	RMD
NXD	LBS	FLW	DRB	JSB

VHT	KRZ	SZN	XBM	TFL
LZC	CPN	DFX	LHJ	WSG

CKZ	HRK	PJM	TMC	PMH
HPF	MBX	TSB	KJP	SKF

MJS	NPX	SFR	WGL	HPG
KDH	QJS	XCL	CFV	MSR

QLX	SLB	TDM	NGH	ZVM
MBR	PMR	KSJ	KZV	SLJ

HKM	FVS	RKX	XPT	MKD
XPL	HDL	XCF	QLW	PZD

Contd....

APPENDIX 5.1

STIMULUS MATERIAL USED IN EXPERIMENTS 5.1 AND 5.2

ONE ROW

HLC	WFC	QFM	GUS	SYM
THD	PDR	XKR	VZK	KSB
BFK	LDS	DXM	LYS	CJK
MZB	SVP	QLC	WKA	RTV
HGK	KMH	RVT	KJC	CNP

XJS WMC

TWO ROWS

KHC	TZA	JVS	FTM	
NXD	LBS	PLW	DHS	
VHT	KRA	BZM	JPK	
YJC	CFM	DPX	LRA	
GKZ	HBK	RJK	TWC	
HFF	MBK	TBS	KJF	
MJS	NFX	SMR	WJL	
KDH	QJS	JCL	CFV	
QIX	BIB	TDK	NGA	
MBR	JHK	-KSV	KAV	
HKM	FVS	NKX	XJY	
XFL	NDL	XOF	QJF	

Contd....

5.2

APPENDIX 5.I (Contd...)

STIMULUS MATERIAL USED IN EXPERIMENTS 5.1 AND 5.2

TWO ROWS

MTZ	TCK	NPF	LXT	TJV
CLP	FMB	KCT	BZR	NPF
BSJ	FWL	PFR	DTS	DQF
HQC	PSK	MTV	FPZ	GSZ
SHG	MCV	KTX	CMW	STQ
LXD	BJL	QMR	RZB	CFH
DLX	SPM	XMK	RDX	DQB
ZFT	CKW	LSW	GNC	TLS
MRB	BZW	QMJ	JCR	DJS
FCN	RCK	NHF	MTX	VGL
KJR	TMY	HKS	DSB	LJW
SPG	LKR	NDF	LVX	CKR

5.3

APPENDIX 5.II

STIMULUS MATERIAL USED IN EXPERIMENT 5.3

Additive Set :	28 - 8 - 36
	58 - 6 - 64
	36 - 7 - 43
	26 - 9 - 35
Lower additive Set:	8 - 28 - 36
	6 - 58 - 64
	7 - 36 - 43
	9 - 26 - 35
Additive Random Set:	36 - 8 - 28
	64 - 6 - 58
	43 - 7 - 36
	35 - 9 - 26

APPENDIX 5.II

STIMULUS MATERIAL USED IN EXPERIMENT 5.3

Additive Set :

28 - 8 - 36

36 - 7 - 43

26 - 9 - 35

28 - 6 - 34

Lower additive Set:

8 - 28 - 36

7 - 36 - 43

9 - 26 - 35

6 - 28 - 34

Additive Random Set:

36 - 8 - 28

43 - 7 - 36

35 - 9 - 26

34 - 6 - 28

APPENDIX 5.III

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ONE ROW CONDITION

	Retention Intervals in Sec							
Subjects	0	1	2	3	6	9	12	18
S1	3.00	3.00	3.00	2.25	2.00	0.75	1.50	1.50
S2	3.00	3.00	3.00	2.75	2.25	1.75	2.50	0.75
S3	3.00	2.75	3.00	2.50	3.00	1.50	2.25	1.75
S4	3.00	2.75	3.00	2.75	2.50	2.00	0.75	1.75
S5	3.00	2.75	2.50	2.50	2.25	2.25	1.00	1.25
S6	3.00	3.00	2.50	2.00	2.00	0.75	1.00	0.00
S7	3.00	3.00	3.00	1.50	0.75	1.25	0.00	0.00
S8	3.00	3.00	3.00	2.75	1.75	1.50	0.00	0.75
S9	3.00	2.75	3.00	2.75	2.25	2.50	0.75	1.75
S10	3.00	3.00	3.00	2.50	1.50	1.25	0.25	0.00

APPENDIX 5.III

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ONE NEW CONDITION

Subjects	Retention Interval in Sec						
	0	1	2	3	6	9	12	15
S1	3.00	3.00	3.00	2.25	2.00	0.75	1.50	1.50
S2	3.00	3.00	3.00	2.75	2.25	1.75	2.50	0.75
S3	3.00	2.75	3.00	2.50	3.00	1.50	2.25	1.75
S4	3.00	2.75	3.00	2.75	2.50	2.00	0.75	1.75
S5	3.00	2.75	2.50	2.50	2.25	2.25	1.00	1.25
S6	3.00	3.00	2.50	2.00	2.00	0.75	1.00	0.00
S7	3.00	3.00	3.00	1.50	0.75	1.25	0.00	0.00
S8	3.00	3.00	3.00	2.75	1.75	1.50	0.00	0.75
S9	3.00	2.75	3.00	2.75	2.25	2.50	0.75	1.75
S10	3.00	3.00	3.00	2.50	1.50	1.25	0.25	0.00

5.5

APPENDIX 5.IV

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR TWO ROWS CONDITION

	Retention Intervals in Sec							
Subjects	0	1	2	3	6	9	12	18
S1	2.75	2.50	1.75	2.00	2.25	0.75	0.00	0.50
S2	2.50	3.00	2.50	2.25	1.75	1.75	1.00	0.75
S3	2.50	1.50	1.75	1.75	1.50	1.25	1.75	0.75
S4	2.75	1.50	1.25	1.75	1.25	1.75	0.75	0.25
S5	2.25	2.00	1.00	1.50	1.25	0.50	0.00	0.75
S6	1.75	2.00	1.00	1.00	0.75	0.25	0.75	0.00
S7	2.75	1.00	3.00	1.50	1.00	0.50	0.50	0.00
S8	3.00	2.50	2.50	1.00	0.75	0.00	0.00	0.50
S9	1.75	2.00	2.00	1.75	2.00	1.00	2.00	0.25
S10	2.50	2.25	2.25	1.50	0.75	0.00	0.00	0.00

5.6

APPENDIX 5.V

RECALL ACCURACY SCORES OF EACH DEAF SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ONE ROW CONDITION

Subjects	Retention Intervals in Sec							
	0	1	2	3	6	9	12	18
S1	2.75	2.50	2.75	2.00	2.25	2.25	2.75	2.75
S2	3.00	2.75	2.50	2.75	2.50	2.00	1.50	1.50
S3	3.00	2.25	1.25	2.25	2.25	1.50	2.00	1.75
S4	3.00	1.50	2.00	2.50	1.25	2.00	1.25	1.50
S5	2.75	2.50	2.25	1.75	2.50	1.50	2.00	1.75
S6	3.00	3.00	2.00	2.75	2.00	2.75	1.25	1.50
S7	3.00	2.50	2.50	2.00	1.75	1.50	2.25	2.25
S8	3.00	2.75	2.50	1.75	2.50	2.00	2.75	2.25
S9	3.00	2.50	2.75	2.50	2.75	3.00	1.75	3.00
S10	2.75	1.25	2.25	2.00	1.25	2.50	1.50	1.75

5.7

APPENDIX 5.VI

RECALL ACCURACY SCORES OF EACH DEAF SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR TWO ROWS CONDITION

	Retention Intervals in Sec							
Subjects	0	1	2	3	6	9	12	18
S1	2.00	1.00	0.50	0.75	1.50	0.75	0.50	0.50
S2	2.00	1.75	1.75	1.50	2.75	2.25	1.25	2.25
S3	1.50	1.00	1.50	1.00	0.50	0.50	0.50	1.25
S4	1.50	1.25	1.75	1.25	1.75	0.50	1.00	0.50
S5	1.50	1.25	0.50	0.75	0.75	0.25	0.25	0.75
S6	3.00	1.75	1.75	2.50	1.00	0.50	1.25	1.25
S7	2.50	1.25	0.75	1.25	1.25	1.50	0.75	1.25
S8	2.50	2.00	1.50	0.75	1.25	1.50	1.25	1.25
S9	0.50	1.00	1.50	1.50	2.00	0.50	1.75	0.75
S10	0.25	0.00	0.50	0.00	0.25	0.75	0.00	0.50

APPENDIX 5.VI

RADIAL ACCURACY CODES OF EACH DLRP SUBPORTS UNDER VARIOUS RETENTION INTERVALS FOR TEN NOMA SUBJECTS

Subjects	Retention Intervals in Sec								
	0	1	2	3	6	9	12	15	
S1	2.00	1.00	0.50	0.75	1.50	0.75	0.50	0.50	
S2	2.00	1.75	1.75	1.50	2.75	2.25	1.25	1.25	
S3	1.50	1.00	1.50	1.00	0.50	0.50	0.50	1.25	
S4	1.50	1.25	1.75	1.25	1.75	0.50	1.00	0.50	
S5	1.50	1.25	0.50	0.75	0.75	0.25	0.25	0.75	
S6	3.00	1.75	1.75	2.50	1.00	0.50	1.25	1.25	
S7	2.50	1.25	0.75	1.25	1.25	1.50	0.75	1.25	
S8	2.50	2.00	1.50	0.75	1.25	1.50	1.25	1.25	
S9	0.50	1.00	1.50	1.50	2.00	0.50	1.75	0.75	
S10	0.25	0.00	0.50	0.00	0.25	0.75	0.00	0.50	

3.8

APPENDIX 5.VII

RECALL ACCURACY SCORES OF EACH SIGHTED SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ONE ROW CONDITION

	Retention Intervals in Sec							
Subjects	0	1	2	3	6	9	12	18
S1	3.00	2.75	2.75	2.50	1.75	1.00	0.25	0.00
S2	3.00	2.00	3.00	1.75	0.75	1.00	0.75	0.00
S3	3.00	2.75	2.50	2.25	1.75	1.75	0.50	1.50
S4	3.00	2.25	2.75	2.50	0.50	0.25	1.50	0.25
S5	2.25	2.50	2.50	2.00	1.00	1.50	1.50	0.25
S6	3.00	2.75	2.50	2.50	0.75	1.25	0.75	0.00
S7	3.00	3.00	2.25	3.00	2.75	0.50	1.50	1.00
S8	2.75	2.75	2.25	2.00	1.25	1.00	1.25	0.75
S9	3.00	2.75	2.25	2.25	1.25	1.25	0.75	0.00
S10	3.00	2.50	2.00	2.25	0.75	1.50	1.50	1.50

5.9

APPENDIX 5.VIII

RECALL ACCURACY SCORES OF EACH SIGHTED SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR TWO ROWS CONDITION

	Retention Intervals in Sec							
Subjects	0	1	2	3	6	9	12	18
S1	2.50	1.25	0.75	1.00	0.00	0.50	0.50	0.00
S2	2.25	0.75	2.25	0.50	0.50	0.75	0.00	0.00
S3	1.75	2.75	2.00	2.25	0.75	0.50	1.00	0.00
S4	2.50	1.50	1.50	2.25	1.00	1.75	0.25	0.00
S5	2.75	2.75	1.50	1.00	1.00	1.00	0.25	0.00
S6	2.75	1.00	1.50	1.00	1.00	0.50	0.00	0.50
S7	2.75	2.00	2.25	2.25	1.50	1.50	1.50	0.50
S8	2.50	1.75	2.25	1.50	0.00	1.25	0.00	0.00
S9	2.50	2.00	1.25	0.75	1.00	0.50	0.00	0.00
S10	2.00	1.50	2.00	1.50	1.75	1.25	1.00	0.50

5.10

APPENDIX 5.IX

RECALL ACCURACY SCORES OF EACH BLIND SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ONE ROW CONDITION

	Retention Intervals in sec							
Subjects	0	1	2	3	6	9	12	18
S1	3.00	3.00	2.75	3.00	2.50	1.50	2.75	2.00
S2	3.00	3.00	2.50	3.00	2.50	3.00	2.75	2.50
S3	2.75	3.00	3.00	3.00	3.00	2.75	3.00	2.25
S4	3.00	3.00	3.00	2.75	2.75	2.50	2.50	3.00
S5	3.00	3.00	2.75	2.75	2.50	1.75	3.00	2.00
S6	3.00	3.00	2.50	3.00	2.75	2.50	1.75	1.25
S7	3.00	3.00	2.25	2.75	3.00	2.75	2.00	2.75
S8	3.00	3.00	3.00	3.00	2.50	2.25	1.50	3.00
S9	3.00	3.00	2.50	3.00	2.50	2.00	2.50	1.75
S10	3.00	3.00	2.75	3.00	3.00	2.75	3.00	2.75

5.11

APPENDIX 5.X

RECALL ACCURACY SCORES OF EACH BLIND SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR TWO ROWS CONDITION

	Retention Invertals in sec							
Subjects	0	1	2	3	6	9	12	18
S1	2.25	2.00	2.25	1.50	2.50	0.75	2.75	0.00
S2	2.50	2.00	1.75	1.75	1.50	3.00	1.25	1.75
S3	3.00	3.00	2.50	2.25	2.00	0.75	1.25	1.50
S4	2.50	2.25	1.50	2.00	2.00	1.50	2.50	2.00
S5	3.00	2.75	3.00	1.75	1.50	1.75	2.25	1.50
S6	3.00	2.50	3.00	2.00	2.50	1.25	1.75	1.50
S7	3.00	2.25	3.00	1.25	1.00	0.00	1.00	2.25
S8	3.00	3.00	2.50	2.75	2.00	1.50	1.25	0.75
S9	3.00	2.75	3.00	2.75	1.75	1.50	1.75	0.25
S10	3.00	2.75	2.75	2.75	2.50	1.75	1.25	1.00

5.12

APPENDIX 5.XI

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ADDITIVE(A) SET

	Retention Intervals in sec			
Subjects	0	3	9	18
S1	3	2	3	0
S2	3	2	2	0
S3	3	2	2	0
S4	3	3	3	1
S5	3	3	2	2
S6	3	3	2	1
S7	3	2	2	0
S8	3	3	2	1
S9	3	3	3	1
S10	3	3	3	2
S11	3	3	3	2
S12	3	3	3	2
S13	3	3	3	1
S14	3	2	3	1
S15	3	3	3	1

APPENDIX S.XI

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ADDITIVE(A) SET

Subjects	Retention Intervals in sec			
	0	3	8	12
S1	3	2	3	0
S2	3	2	0	0
S3	3	2	2	0
S4	3	3	3	1
S5	3	3	2	2
S6	3	3	2	1
S7	3	2	2	0
S8	3	3	2	1
S9	3	3	3	1
S10	3	2	1	2
S11	3	3	3	2
S12	3	2	3	2
S13	3	3	2	1
S14	3	2	3	1
S15	3	3	3	1

5.13

APPENDIX 5.XII

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR LOWER ADDITIVE (LA) SET

	Retention Intervals in sec			
Subjects	0	3	9	18
S1	3	2	2	1
S2	3	1	2	0
S3	3	2	1	2
S4	2	3	0	1
S5	3	3	2	1
S6	3	2	1	2
S7	3	1	2	1
S8	3	3	2	0
S9	2	3	3	1
S10	3	2	1	1
S11	3	2	2	1
S12	3	1	1	1
S13	3	1	2	2
S14	3	2	1	0
S15	3	1	1	1

5.14

APPENDIX 5.XIII

RECALL ACCURACY SCORES OF EACH HEARING SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ADDITIVE RANDOM (AR) SET

	Retention Intervals in sec			
Subjects	0	3	6	18
S1	3	2	2	1
S2	3	3	1	0
S3	3	3	2	2
S4	3	2	0	1
S5	3	3	2	1
S6	3	3	2	2
S7	3	3	3	1
S8	3	3	1	3
S9	3	3	2	1
S10	3	3	3	2
S11	3	3	3	0
S12	3	3	2	1
S13	3	3	1	1
S14	3	3	0	2
S15	3	3	3	1

5.15

APPENDIX 5.XIV

RECALL ACCURACY SCORES OF EACH DEAF SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ADDITIVE (A) SET

	Retention Intervals in sec			
Subjects	0	3	9	18
S1	2	2	1	1
S2	3	3	3	3
S3	3	3	3	3
S4	3	2	3	3
S5	3	3	3	3
S6	3	3	3	2
S7	3	3	3	1
S8	3	2	2	3
S9	3	3	1	1
S10	3	2	3	1
S11	3	1	2	1
S12	3	3	3	2
S13	1	3	0	0
S14	3	1	3	0
S15	2	2	3	1

APPENDIX 5.XV

RECALL ACCURACY SCORES OF EACH DEAF SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR LOWER ADDITIVE (LA) SET

	Retention Intervals in sec			
Subjects	0	3	6	18
S1	2	3	1	3
S2	3	3	3	3
S3	3	3	3	2
S4	3	0	1	0
S5	1	1	1	2
S6	3	1	0	2
S7	1	3	0	0
S8	3	0	3	2
S9	3	0	1	1
S10	3	0	3	1
S11	1	0	0	0
S12	3	1	3	2
S13	1	1	1	0
S14	3	3	2	1
S15	1	2	1	2

5.17

APPENDIX 5.XVI

RECALL ACCURACY SCORES OF EACH DEAF SUBJECTS UNDER VARIOUS RETENTION INTERVALS FOR ADDITIVE RANDOM (AR) SET

	Retention Intervals in sec			
Subjects	0	3	6	18
S1	3	1	2	1
S2	3	3	3	2
S3	3	3	3	3
S4	1	2	2	1
S5	3	3	3	3
S6	3	1	2	1
S7	2	2	1	2
S8	2	3	3	1
S9	1	2	1	0
S10	3	3	2	1
S11	1	0	1	0
S12	1	2	1	3
S13	2	3	3	0
S14	1	2	3	0
S15	3	1	1	0

Subjects	0	3	6	12
S1	3	1	2	1
S2	3	3	3	2
S3	3	3	2	3
S4	1	2	2	1
S5	3	3	3	3
S6	3	1	2	1
S7	2	2	1	2
S8	2	3	3	1
S9	1	2	1	0
S10	3	3	2	1
S11	1	0	1	0
S12	1	2	1	3
S13	2	3	3	0
S14	1	2	3	0
S15	3	1	1	0

A SAMPLE COMPUTER PROGRAM FOR EXPERIMENT 5 : FINAL PROGRAM FOR EXPERIMENTAL DESIGN SFF.Pr.qu v ANOVA TEST INVOLVING 2x2x3x3x3 FACTORS (Groups Blind/Sighted, Information, Location/Distance, Retention Intervals - 0, 15, and 50 Sec., NUMBER OF PRIOR ANCTIVITIES - 0, 2 and 4, TARGETS - 10 cm/30°, 20 cm/70°, 30 cm/110°)

```
C     EXPERIMENT 5  DECK 2
      DIMENSION   ANAM (35)
      DATA ANAM/1HX,1HA,1HB,1HC,1HD,1HE,2HAB,2HAD,2HAE,2HBC,2HCD,2HCE,
     12HAC,2HBD,2HBE,2HDE,3HABC,3HACD,3HACE,3HABD,3HABE,3HBCD,3HBCE,
     23HBDE,3HCDE,3HADE,4HABCD,4HABCE,4HACDE,4HABDE,4HBCDE,3HACS,
     34HABCS,4HACDS,4HACES/
      DIMENSION DCF(43),MS(43),F(43)
      DIMENSION ABCDES(28,28),ABCES(28,11),ACDES(28,11),ABCS(28,5),ACDS
     (128,5),ACES(28,5),ACS(14,4),ABCDE(4,29),ABCD(4,11),ABCE(4,11)
     ACDE(14.11),      ABDE(2,29),ABC(4,5),ACD(4,5)ACE(4,5),ABD(2,11),B
     1CD(2,11),ABE(2,11),BCE(2.11),ADE(2.11),CDE(2,11)BDE(3,11),AB(2,5)
     1,BC(2,5),AD(2,5),AE(2,5),CD(2,5),CE(2,5),AC(2,4)BD(3,5),BE(3,5),D
     1E(3,5),NAMA(1Ø),NAMB(29),STO(1,29),BCDE(2,29)ABCDS(28,11)
      REAL N,N1,MS
      COMMON NFLAG
      DATA P,R,Q,U,V.N,N1/2*2.Ø3*3.Ø,7.Ø,28.Ø/
      DATA NAMA/4HABCD,2HES,4HABCD,1HS,4HABCE,1HS,4HACDE,1HS,4HABCD,1HE/
      DATA NAMB/4HABCS,4HACDS,4HACES,3HACS,4HABCD,4HABCE,4HACDE,4HABDE,4
     1HBCDE,3HABC,3HACD,3HACE,3HABD,3HBCD,3HABE,3HBCE,3HADE,3HCDE,HBDE,
     12HAB,2HBC,2HAD,2HAE,2HCD,2HCE,2HAC,2HBD,2HBE,2HDE/
      DATA ABCDES/784*0./,ABCES,ACDES/616*0./,ABCS,ACDS,ACES/420*0./,ACS
     2Ø*0./,AC8
```

```
2       1,ABCDE/172*0./,ABCD,ABCE,ACDE/132*0./,ABDE,BCDE/116*0./,ABC,ACD,A
        1CE/60*0./,ABD,BCD,ABE,BCE,ADE,CDE/132*0./,AB,BC,AD,AE,CD,CE,BD,BE/
        190*0./,BDE,AC,DE/56*0./
C        INPUT AND ABCDES TABLE
         CALL INIT (A61,GRSUM)
         READ 1000,NFLAG
1000    FORMAT(I1)
        DO 1 I=1,4
        CALL INPUT (1,7,I,ABCDES)
        CALL INPUT (2,8,I,ABCDES)
        CALL INPUT (3,9,I,ABCDES)
        CALL INPUT (10,16,I,ABCDES)
        CALL INPUT (11.17,I,ABCDES)
        CALL INPUT (12,18,I,ABCDES)
        CALL INPUT (19,25,I,ABCDES)
        CALL INPUT (20,26,I,ABCDES)
    1   CALL INPUT (21,27,I,ABCDES)
        DO 2 I=1,28
        DO 3 J=1,27
        ABCDES(I,28)=ABCDES(I,28)+ABCDES(I,J)
    3   A61=A61+ABCDES(I,J)**2
    2   GRSUM=GRSUM+ABCDES(I,28)
        PRINTS,NAMA(1),NAMA(2)
    5   FORMAT(1HO,////5X,2A4,6H-TABLE)
        PRINT 6
    6   FORMAT(1HO,12HS0SLS0MLS0LL,12HS2SLS2MLS2LL,12HS4SLS4MLS4LL,
        1   12HM0SLM0MLM0LL,12HM2SLM2MLM2LL,12HM4SLM4MLM4LL,12HL0SLL0MLL0LL,
        1   12HL2SLL2MLL,12HL4SLL4MLL4LL,2X,3HSUM)
```

```
3          PRINT 7,((ABCDES(I,J),J=1,28),I=1,28)
 7       FORMAT(1HO,8F4.1,F5.1,2F4.1,F5.1,2F4.1,F5.1,2F4.1,10F5.1,F6.2)
          PRINT 8,GRSUM,A61
 8       FORMAT(1HO,5X,6HGRSUM=,F12.3,5X,7HGRSQSM=,F12.3)
          GRSUMX=GRSUM
C         ABCDS TABLE FROM ABCDES
          CALL COLM1(ABCDS,ABCDES,28,11,28,28,3,GRSUM,GRSQSM)
          PRINT 5,NAMA(3),NAMA(4)
          PRINT 10
10        FORMAT(1HO,4X,4HSIOP,8X,4HSI2P,8X,4HSI4P,8X,4HMIOP,8X,4HMI2P,
         1 8X,4HMI4P,8X,4HLIOP,8X,4HLI2P,8X,4HLI4P,8X,3HSUM,
          29X,5HSQSUM)
          CALL OUTPUT(ABCES,28,11,GRSUM,GRSQSM)
          ABCDS1=GRSQSM/V
C         ABCES TABLE FROM ABCDES
          CALL INIT(GRSUM,GRSQSM)
           DO 15 I=1, 28
          DO 16 J=1, 9
          JA=J
          IF(J.LE.6.AND.J.GT.3)JA=J+6
          IF(J.GT.6)JA=J+12
          ABCES(I,J)=ABCDES(I,JA)+ABCDES(I,JA+3)+ABCDES(I,JA+6)
          ABCES(I,10)=ABCES(I,10)+ABCES(I,J)
16        ABCES(I,11)=ABCES(I,11)+ABCES(I,J)**2
          GRSUM=GRSUM+ABCES(I,10)
15        GRSQSM=GRSQSM+ABCES(I,11)
          PRINT 5,NAMA(5),NAMA(6)
```

```
4          PRINT 17
        17 FORMAT(1HO,4X,4HBISL,8X,4HSIML,8X,4HSILL,8X,4HMISL,8X,
                                                    4HMIML,8X,4H
          1MILL,8X,4HLISL,8X,4HLIML,8X,4HLILL,8X,3HSUM,9X,5HSQSUM)
           CALL OUTPUT(ABCES,28,11,GRSUM,GRSQSM)
           ABCES1=GRSQSM/U
C          ACDES TABLE FROM ABCDES
           CALL COLM2(ACDES,ABCDES,28,11,28,28,9,GRSUM,GRSQSM)
           PRINT 5,NAMA(7), NAMA(8)
           PRINT 22
        22 FORMAT(1HO,4X,4HOPSL,8X,4HOPML,8X,4HOPLL,8X,4H2PSL,8X,
                                                    4H2PML,8X,4H
          12PLL,8X,4H4PSL,8X,4H4PML,8X,4H4PLL,8X,3HSUM,9X,5HSQSUM)
           CALL OUTPUT(ACDES,28,11,GRSUM,GRSQSM)
           ACDES1=GRSQSM/Q
C          ABCS TABLE FROM ABCDWS
           CALL COLM1(ABCS,ABCDES,28,5,28,28,9,GRSUM,GRSQSM)
           PRINT 35,NAMB(1)
        35 FORMAT(1HO,////5X,A4,6H-TABLE)
           PRINT 36
        36 FORMAT(1HO,5X,2HSI,9X2HMI,9X,2HLI,9X,3HSUM,7X,5HSQSUM)
           CALL OUTPUT(ABCS,28,5,GRSUM,GRSQSM)
           ABCS1=GRSQSM/(U*V)
C          ACDS TABLE FROM ABCDES
           CALL INIT(GRSUM,GRSQSM)
           PRINT 35,NAMB(2)
           PRINT 40
```

```
5       40      40 FORMAT(1HO,5X,2HOP,9X,2H2P,9X,2H4P,9X,3HSUM,7X,5HSQSUM)
                   DO 41 II=1,28
                   DO 42 I=1,3
                   DO 42 J=1,3
                   J1=3*(I-1)+J
                42 ACDS(II,I)=ACDS(II,I)+ABCDES(II,J1)+ABCDES(II,J1+9)+ABCDES(II,J1+
                  118)
                   ACDS(II,4)=ACDS(II,1)+ACDS(II,2)+ACDS(II,3)
                   ACDS(II,5)=ACDS(II,1)**2+ACDS(II,2)**2+ACDS(II,3)**2
                   GRSUM=GRSUM+ACDS(II,4)
                41 GRSQSM=GRSQSM+ACDS(II,5)
                   CALL OUTPUT(ACDS,28,5,GRSUM,GRSQSM)
                   ACDS1=GRSQSM/(Q*V)
            C      ACES TABLE FROM ABCDES
                   CALL INIT(GRSUM,GRSQSM)
                   DO 50 I=1,28
                   DO 51 J=1,3
                   DO 52 JA=1,25,3
                   JZ=JA
                   iF(J.EQ.2)JZ=JA+1
                   IF(J.EQ.3)JZ=JA+2
                52 ACES(I,J)=ACES(I,J)+ABCDES(I,JZ)
                   ACES(I,4)=ACES(I,4)+ACES(I,J)
                51 ACES(I,5)=ACES(I,5)+ACES(I.J)**2
                   GRSUM=GRSUM+ACES(1,4)
                50 GRSQSM=GRSQSM+ACES(I,5)
```

```
6          PRINT 35,NAMB(3)
           PRINT 53
       53  FORMAT(1HO,5X,2HSL,9X,2HML,9X,2HLL,6X,3HSUM,8X,5HSQSUM)
           CALL OUTPUT(ACES,28,5,GRSUM,GRSQSM)
           ACES1=GRSQSM/(Q*U)
C          ACS TABLE FROM ABCDES
           CALL INIT(GRSUM,GRSQSM)
           DO 60 I=1,7
           ACS(I,1)=ABCDES(I,28)
           ACS(I,2)=ABCDES(I+7,28)
           ACS(I+7,1)=ABCDES(I+14,28)
       60  ACS(I+7,2)=ABCDES(I+21,28)
           DO 61 I=1,14
           DO 62 J=1,2
           ACS(I,3)=ACS(I,3)+ACS(I.J)
       62  ACS(I,4)=ACS(I,4)+ACS(I,J)**2
           GRSUM=GRSUM+ACS(I,3)
       61  GRSQSM=GRSQSM+ACS(I,4)
           PRINT 35,NAMB(4)
           PRINT 63
       63  FORMAT(1HO,6X,1HL,11X,1HD,11X,3HSUM,9X,5HSQSM)
           CALL OUTPUT(ACS,14,4,GRSUM,GRSQSM)
           ACS1=GRSQSM/(Q*U*V)
C          ABCDE TABLE FROM ABCDES
           CALL MERG2(ABCDE,ABCDES,4,29,28,28,7, GRSUM,GRSQWM)
           PRINT 5,NAMA(9),NAMA(10)
           PRINT 6
```

```
7          PRINT 67,((ABCDE(I,J),I=1,4),J=1,28)
      67   FORMAT(1HO,4F10.2)
           PRINT 8,GRSUM,GRSQSM
           ABCDE1=GRSQSM/N
C          ABCD TABLE FROM ABCDS
           CALL MERG2(ABCD,ABCDS,4,11,28,11,7,GRSUM,GRSQSM)
           PRINT 35,NAMB(5)
           PRINT 10
           CALL OUTPUT(ABCD,4,11,GRSUM,GRSQSM)
           ABCD1=GRSQSM/(N*V)
C          ABCE TABLE FROM ABCES
           CALL MERG2(ABCE,ABCES,4,11,28,11,7,GRSUM,GRSQSM)
           PRINT 35,NAMB(6)
           PRINT 17
           CALL OUTPUT(ABCE,4,11,GRSUM,GRSQSM)
           ABCE1=GRSQSM/(N*U)
C          ACDE TABLE FROM ACDES
           CALL MERG2(ACDE,ACDES,4,11,28,11,7,GRSUM,GRSQSM)
           PRINT 35, NAMB(7)
           PRINT 22
           CALL OUTPUT(ACDE,4,11,GRSUM,GRSQSM)
           ACDE1=GRSQSM/(N*Q)
C          ABDE TABLE FROM ABCDE
           CALL MERG2(ABDE,ABCDE,2,29,4,29,2,GRSUM,GRSQSM)
           PRINT 35,NAMB(8)
           PRINT 6
```

```
8           PRINT 68,((ABDE(I,J),I=1,2),J=1,28)
   68       FORMAT(1HO,2F10.2)
            PRINT 8, GRSUM,GRSQSM
            ABDE1=GRSQSM/(N*R)
C           BCDE TABLE FROM ABCDE
            CALL MERG3(BCDE,ABCDE,2,29,4,29,GRSUM,GRSQSM)
            PRINT 35,NAMB(9)
            PRINT 6
            PRINT 68,((BCDE(I,J),I=1,2)J=1,28)
            PRINT 8,GRSUM,GRSQSM
            BCDE1=GRSQSM/(N*P)
C           ABC TABLE FROM ABCD
            CALL COLM1(ABC,ABCD,4,5,4,11,3,GRSUM,GRSQSM)
            PRINT 35, NAMB(10)
            PRINT 36
            CALL OUTPUT (ABC,4,5, GRSUM,GRSQSM)
            ABC1=GRSQSM/(N*U*V)
C           ACD TABLE FROM ABCD
            CALL COLM2(ACD,ABCD,4,5,4,11,3,GRSUM,GRSQSM)
            PRINT 35,NAMB(11)
            PRINT 40
            CALL OUTPUT(ACD,4,5,GRSUM,GRSQSM)
            ACD1=GRSQSM/(N*Q*V)
C           ACE TABLE FROM ABCE
            CALL COLM2(ACE,ABCE,4,5,4,11,3,GRSUM,GRSQSM)
            PRINT 35, NAMB(12)
            PRINT 53
```

```
9          CALL OUTPUT(ACE,4,5,GRSUM,GRSQSM)
           ACE1=GRSQSM/(N*Q*U)
C          ABD TABLE FROM ABCD
           CALL MERG2(ABD,ABCD,2,11,4,11,2, GRSUM,GRSQSM)
           PRINT 35,NAMB(13)
           PRINT 10
           CALL OUTPUT(ABD,2,11,GRSUM,GRSQSM)
           ABD1=GRSQSM/(N*R*V)
C          BCD TABLE FROM ABCD
           CALL MERG3(BCD,ABCD,2,11,4,11,GRSUM,GRSQSM)
           PRINT 35,NAMB(14)
           PRINT 10
           CALL OUTPUT(BCD,2,11,GRSUM,GRSQSM)
           BCD1=GRSQSM/(N*P*V)
C          ABE TABLE FROM ABCE
           CALL MERG2(ABE,ABCE,2,11,4,11,2,GRSUM,GRSQSM)
           PRINT 35,NAMB(15)
           PRINT 17
           CALL OUTPUT(ABE,2,11,GRSUM,GRSQSM)
           ABE1=GRSQSM/(N*R*U)
C          BCE TABLE FROM ABCE
           CALL MERG3(BCE,ABCE,2,11,4,11,GRSUM,GRSQSM)
           PRINT 35,NAMB(16)
           PRINT 17
           CALL OUTPUT(BCE,2,11,     GRSUM,GRSQSM)
           PRINT 35, NAMB(16)
           PRINT 17
```

```
10          CALL OUTPUT(BCE,2,11,GRSUM,GRSQSM)
            BCE1=GRSQSM/(N*P*U)
C           ADE TABLE FROM ACD
            CALL MERG2(ADE,ACDE,2,11,4,11,2,GRSUM,GRSQSM)
            PRINT 35,NAMB(17)
            PRINT 22
            CALL OUTPUT(ADE,2,11,GRSUM,GRSQSM)
            ADE1=GRSQSM/(N*Q*R)
C           CDE TABLE FROM ACDE
            CALL MERG3(CDE,ACDE,2,11,4,11,GRSUM,GRSQSM)
            PRINT 35,NAMB(18)
            PRINT 22
            CALL OUTPUT(CDE,2,11,GRSUM,GRSQSM)
            CDE1=GRSQSM/(N*P*Q)
C           BDE TABLE FROM ABDE
            CALL ARRANGE(BDE,ABDE,3,11,2,29, GRSUM,GRSQSM)
            PRING 35,NAMB(19)
            PRINT 22
            CALL OUTPUT(BDE,3,11,GRSUM,GRSQSM)
            BDE1=GRSQSM/(N*P*R)
C           AB TABLE FROM ABC
            CALL MERG2(AB,ABC,2,5,4,5,2,GRSUM,GRSQSM)
            PRINT 35,NAMB(20)
            PRINT 36
            CALL OUTPUT(AB,2,5,GRSUM,GRSQSM)
            AB1=GRSQSM/(N*R*U*V)
```

```
11          C       BC TABLE FROM ABC
                    CALL MERG3(BC,ABC,2,5,4,5,GRSUM,GRSQSM)
                    PRINT 35,NAMB(21)
                    PRINT 36
                    CALL OUTPUT(BC,2,5,GRSUM,GRSQSM)
                    BC1=GRSQSM/(N*P*U*V)
            C       AD TABLE FROM ADE
                    CALL COLM1(AD,ADE,2,5,2,11,3,GRSUM,GRSQSM)
                    PRINT 35,NAMB(22)
                    PRINT 40
                    CALL OUTPUT(AD,2,5,GRSUM,GRSQSM)
                    AD1=GRSQSM/(N*Q*R*V)
            C       AE TABLE FROM ADE
                    CALL COLM2(AE,ADE,2,5,2,11,3,GRSUM,GRSQSM)
                    PRINT 35,NAMB(23)
                    PRINT 53
                    CALL OUTPUT(AE,2,5,GRSUM,GRSQSM)
                    AE1=GRØSQSM/(N*Q*R*U)
            C       CD TABLE FROM CDE
                    CALL COLM1(CD,CDE,2,5,2,11,3,GRSUM,GRSQSM)
                    PRINT 35,NAMB(24)
                    PRINT 40
                    CALL OUTPUT(CD,2,5,GRSUM,GRSQSM)
                    CD1=GRSQSM/(N*P*Q*V)
            C       CE TABLE FROM CDE
                    CALL COLM2(CE,CDE,2,5,2,11,3,GRSUM,GRSQSM)
```

```
12          PRINT 35,NAMB(25)
            PRINT 53
            CALL OUTPUT(CE,2,5,GRSUM,GRSQSM)
            CE1=GRSQSM/(N*P*Q*U)
C           AC TABLE FROM ACD
            CALL INIT(GRSUM,GRSQSM)
            AC(1,1)=ACD(1,1)+ACD(1,2)+ACD(1,3)
            AC(1,2)=ACD(2,1)+ACD(2,2)+ACD(2,3)
            AC(2,1)=ACD(3,1)+ACD(3,2)+ACD(3,3)
            AC(2,2)=ACD(4,1)+ACD(4,2)+ACD(4,3)
            DO 80 I=1,2
            DO 81 J=1,2
            AC(I,3)=AC(I,3)+AC(I,J)
 81         AC(I,4)=AC(I,4)+AC(I,J)**2
            GRSUM=GRSUM+AC(I,3)
 80         GRSQSM=GRSQSM+AC(I,4)
            PRINT 35,NAMB(26)
            PRINT 63
            CALL OUTPUT(AC,2,4,GRSUM,GRSQSM)
            AC1=GRSQSM/(N*Q*U*V)
C           BD TABLE FROM BDE
            CALL COLM1(BD,BDE,3,5,3,11,3,GRSUM,GRSQSM)
            PRINT 35,NAMB(27)
            PRINT 40
            CALL OUTPUT(BD,3,5,GRSUM,GRSQSM)
            BD1=GRSQSM/(N*P*R*V)
C           BE TABLE FROM BDE
            CALL COLM2(BE,BDE,3,5,3,11,3,GRSUM,GRSQSM)
            PRINT 35,NAMB(28)
            PRINT 53
            CALL OUTPUT(BE,3,5,GRSUM,GRSQSM)
            BE1=GRSQSM/(N*P*R*U)
C           DE TABLE FROM BDE
            CALL MERG2(STO,BDE,1,11,3,11,3, GRSUM,GRSQSM)
```

```
13              DO 90 I=1,3
                DO 90 J=1,3
                JA=3*I-3+J
                DE(I,J)=STO(1,JA)
                DE(I,4)=DE(I,4)+DE(I,J)
     90         DE(I,5)=DE(I,5)+DE(I,J)**2
                PRINT 35,NAMB(29)
                PRINT 53
                CALL OUTPUT(DE,3,5,GRSUM,GRSQSM)
                DE1=GRSQSM/(N*P*Q*R)
C               A TABLE FROM AB
                S=AB(1,1)+AB(1,2)+AB(1,3)
                B=AB(2,1)+AB(2,2)+AB(2,3)
                PRINT 100,S,B
    100         FORMAT(1HO,////5X,2HS=F12.3,5X,2HB=,F12.3)
                A1=(S**2+B**2)/(N*Q*R*U*V)
C               B TABLE FROM AB
                ASI=AB(1,1)+AB(2,1)
                AMI=AB(1,2)+AB(2,2)
                ALI=AB(1,3)+AB'2,3)
                PRINT 110,ASI,AMI,ALI
    110         FORMAT(1HO,////5X,3HSI=,F12.3,5X,3HMI=,F12.3,5X,3HLI=,F12.3)
                B1=(ASI**2+AMI**2+ALI**2)/(N*P*R*U*V)
C               C TABLE FROM AC
                AL=AC(1,1)+AC(2,1)
                AQ=AC(1,2)+AC(2,2)
                PRINT 120,AL,AQ
    120         FORMAT(1HO,////5X,2HL=,F12.3,5X,2HD=,F12.3)
                C1=(AL**2+AQ**2)/(N*P*Q*U*V)
C               D TABLE FROM BD
                D11=BD(1,1)+BD(2,1)+BD(3,1)
                D12=BD(1,2)+BD(2,2)+BD(3,2)
                D13=BD(1,3)+BD(2,2)+BD(3,3)
                D1=(D11**2+D12**2+D13**2)/(N*P*R*Q*V)
                PRINT 130,D11,D12,D13
```

```
14          130  FORMAT(1HO,////5X,3HOP=,F12.3,5X,3H2P=,F12.3,5X,3H4P=,F12.3)
C                E TABLE FROM BE
                 E11=BE(1,1)+BE(2,1)+BE(3,1)
                 E12=BE(1,2)+BE(2,2)+BE(3,2)
                 E13=BE(1,3)+BE(2,3)+BE(3,3)
                 E1=(E11**2+E12**2+E13**2)/(N*P*R*Q*U)
                 PRINT 140,E11,E12,E13
            140  FORMAT(1HO,////5X,3HSL=,F12.3,5X,3HML=,F12.3,5X,3HLL=,F12.3)
                 X=GRSUMX**2/(Q*U*V*N1)
                 PRINT 400,GRSUMX
            400  FORMAT(1HO,15X,5HGRSUM,4X,F12.2)
                 PRINT 402,ANAM(1)X
                 PRINT 402,ANAM(2),A1
            402  FORMAT(1HO,15X,A4,8X,F12.2)
                 PRINT 402,ANAM(3),B1
                 PRINT 402,ANAM(4),C1
                 PRINT 402,ANAM(5),D1
                 PRINT 402,ANAM(6),E1
                 PRINT 402,ANAM(7),AB1
                 PRINT 402,ANAM(8),AD1
                 PRINT 402,ANAM(9),AE1
                 PRINT 402,ANAM(10),BC1
                 PRINT 402,ANAM(11),CD1
                 PRINT 402,ANAM(12),CE1
                 PRINT 402,ANAM(13),AC1
                 PRINT 402,ANAM(14),BD1
                 PRINT 402,ANAM(15),BE1
                 PRINT 402,ANAM(16),DE1
                 PRINT 402,ANAM(17),ABC1
                 PRINT 402,ANAM(18),ACD1
                 PRINT 402,ANAM(19),ACE1
                 PRINT 402,ANAM(20),ABD1
                 PRINT 402,ANAM(21),ABE1
                 PRINT 402,ANAM(22),BCD1
                 PRINT 402,ANAM(23),BCE1
```

```
15          PRINT 402,ANAM(24)BDE1
            PRINT 402,ANAM(25)CDE1
            PRINT 402,ANAM(26),ADE1
            PRINT 402,ANAM(27),ABCD1
            PRINT 402,ANAM(28),ABCE1
            PRINT 402,ANAM(29),ACDE1
            PRINT 402,ANAM(30),ABDE1
            PRINT 402,ANAM(31),BCDE1
            PRINT 402,ANAM(32),ACS1
            PRINT 402,ANAM(33),ABCS1
            PRINT 402,ANAM(34),ACDS1
            PRINT 402,ANAM(35),ACES1

            PRINT 474, ABCDS1
    474     FORMAT(1HO,15X,5HABCDS,4X,F12.2)
            PRINT 476,ABCES1
    476     FORMAT(1HO,15X,5HABCES,4X,F12.2)
            PRINT 478,ACDES1
    478     FORMAT (1HO,15X,5HACDES,4X,F12.2)
            PRINT 480,A61
    480     FORMAT(1HO,15X,6HABCDES,3X,F12.2)
C***        COMPUTING ANOVA TABLE
            SS5=ACS1-AC1
            DOF(5)=P*R*(N-1.0)
            MS(5)=SS5/DCF(5)
            PRINT 500
    500     FORMAT(1HO,////12X,6HSOURCE,12X,2HSS,10X,3HDOF,6X,2HMS,12X,1HF)
            SS1=ACS1-X
            DOF(1)=N*P*R-1.0
            PRINT 510,SS1,DOF(1)
    510     FORMAT(1HO,12X,6HSSBSUB,7X,F10.2,4X,F5.1)
            SSA=A1-X
            DOF(2)=P-1.0
            MS(2)=SSA/DOF(2)
            F(2)=MS(2)/MS(5)
            PRINT 520,SSA,DOF(2),MS(2),F(2)
```

```
16          520   FORMAT(1HO,12X,3HSSA,10X,F10.2,3F10.2)
                  SSC=C1-X
                  DOF(3)=R-1.0
                  MS(3)=SSC/DOF(3)
                  F(3)=MS(3)/MS(5)
                  PRINT 530,SSC,DOF(3),MS(3),F(3)
              530 FORMAT(1HO,12X,3HSSC,10X,F10.2,3F10.2)
                  SSAC=AC1-A1-C1+X
                  DOF(4)=(P-1.0)*(R-1.0)
                  MS(4)=SSAC/DOF(4)
                  F(4)=MS(4)/MS(5)
                  PRINT 540,SSAC,DOF(4),MS(4),F(4)
              540 FORMAT(1HO,12X,4HSSAC,9X,4F10.2)
                  PRINT 545,SS5,DOF(5),MS(5)
              545 FORMAT(1HO,12X,8HSSSUBWGR,5X,3F10.2)
                  SS11=ABCS1-ABC1-ACS1+AC1
                  DOF(11)=P*R*(N-1.0)*(Q-1.0)
                  MS(11)=SS11/DOF(11)
                  SS6=A61-ACS1
                  DOF(6)=N*P*R*(Q*U*V-1.0)
                  PRINT 550,SS6,DOF(6)
              550 FORMAT(1HO,12X,7HSSWNSUB,6X,2F10.2)
                   SSB=B1-X
                  DOF(7)=Q-1.0
                  MS(7)=SSB/DOF(7)
                  F(7)=MS(7)/MS(11)
                  PRINT 560,SSB,DOF(7),MS(7),F(7)
                  SSAB=AB1-A1-B1+X
                  DOF(8)=(P-1.0)*(Q-1.0)
              560 FORMAT(1HO,12X,3HSSB,4F10.2)
                  MS(8)=SSAB/DOF(8)
                  F(8)=MS(8)/MS(11)
                  PRINT 570,SSAB,DOF(8),MS(8),F(8)
              570 FORMAT(1HO,12X,4HSSAB,9X,4F10.2)
```

```
17          SSBC=BC1-B1-C1+X
            DOF(9)=(Q-1.0)*(R-1.0)
            MS(9)=SSBC/DOF(9)
            F(9)=MS(9)/MS(11)
            PRINT 580,SSBC.DOF(9),MS(9),F(9)
580         FORMAT(1HO,12X,4HSSBC,9X,4F10.2)
            SSABC=ABC1-AB1-AC1-BC1+A1+B1+C1-X
            DOF(10)=(P-1.0)*(Q-1.0)*(R-1.0)
            MS(10)=SSABC/DOF(10)
            F(10)=MS(10)/MS(11)
            PRINT 590,SSABC,DOF(10),MS(10),F(10)
590         FORMAT(1HO,12X,5HABC, 8X,4F10.2)
            PRINT  595,SS11,DOF(11),MS(11)
595         FORMAT(1HO,12X,9HSSBSUBWGR,4X,3F10.2)
            SS16=ACDS1-ACD1-ACS1+AC1
            DOF(16)=P*R*(N-1.0)*(U-1.0)
            MS(16)=SS16/DOF(16)
            SSD=D1-X
            DOF(12)=U-1.0
            MS(12)=SSD/DOF(12)
            F(12)=MS(12)/MS(16)
            PRINT 600,SSD,DOF(12),MS(12),F(12)
600         FORMAT(1HO,12X,3HSSD,10X,4F10.2)
            SSAD=AD1-A1-D1+X
            DOF(13)=(P-1.0)*(U-1.0)
            MS(13)=SSAD/DOF(13)
            F(13)=MS(13)/MS(16)
            PRINT 610,SSAD,DOF(13),MS(13),F(13)
            SSCD=CD1-C1-D1+X
610         FORMAT(1HO,4HSSAD,9X,4F10.2)
            DOF(14)=(R-1.0)*(U-1.0)
            MS(14)=SSCD/DOF(14)
            F(14)=MS(14)/MS(16)
            PRINT 620,SSCD,DOF(14),MS(14),F(14)
```

```
      SSZ1=ACOS1-ACOE1-ACOS1+ACO1
695   FORMAT(1H0,10X,9HSSDSUBMGR,4X,3E10.2)
```

```
18
      620   FORMAT(1HO.10X,4HSSCD,9X,4F10.2)
            SSACD=ACD1-AC1-CD1+A1+C1+D1-X-AD1
            DOF(15)=(P-1.0)*(R-1.0)*(U-1.0)
            MS(15)=SSACD/DOF(15)
            F(15)=MS(15)/MS(16)
            PRINT 630,SSACD,DOF(15),MS(15)F(15)
      630   FORMAT(1HO.10X,5HSSACD,8X,4F10.2)
            PRINT 635,SS16,DOF(16),MS(16)
      635   FORMAT(1HO.10X,9HSSDSUBWGR,4X,3F10.2)
            SS21=ACES1-ACE1-ACS1+AC1
            DOF(21)=P*R*(N-1.0)*(V-1.Ø)
            MS(21)=SS21/DOF(21)
            SSE=E1-X
            DOF(17)=V-1.0
            MS(17)=SSE/DOF(17)
            F(17)=MS(17)/MS(21)
            PRINT 640,SSE,DOF(17),MS(17),F(17)
            SSAE=AE1-A1-E1+X
      640   FORMAT(1HO.10X,3HSSE,10X,3F10.2,F10.2)
            DOF(18)==(P-1.0)*(V-1.0)
            MS(18)=SSAE/DOF(18)
            F(18)=MS(18)/MS(21)
            PRINT 650,SSAE,DOF(18),MS(18),F(18)
      650   FORMAT(1.HO.10X,4HSSAE,9X,4F10.2)
            SSCE-CE1-C1-E1+X
            DOF(19)=(R-1.0)*(V-1.0)
            MS(19)=SSCE/DOF(19)
            F(19)=MS(19)/MS(21)
            PRINT 660,SSCE,DOF(19),MS(19),F(19)
      660   FORMAT(11HO.10X,4HSSCE,9X,4F10.2)
            SSACE=ACE1-AC1-AE1-CE1+A1+C1+E1-X
            DOF(20)=(P-1.0)*(R-1.0)*(V-1.0)
            MS(20)=SSACE/DOF(20)
            F(20=MS(20)/MS(21)
```

```
19          PRINT 670,SSACE,DOF(20),MS(20),F(20)
670         FORMAT(1HO,10X,5HSSACE,8X,4F10.2)
            PRINT 675,SS21,DOF(21),MS(21)
675         FORMAT(1HO.10X,9HSSESUBWGR,4X,3F10.2)
            SS26=ABCDS1-ABCD1-ABCS1-ACDS1+ABC1+ACD1+ACS1-AC1
            DOF(26)=P*R*(Q-1.0)*(U-1.0)*(N-1.0)
            MS(26)=SS26/DOF(26)
            SSBD=BD1-B1-D1+X
            DOF(22)=(Q-1.0)*(U-1.0)
            MS(22)=SSBD/DOF(22)
            F(22)=MS(22)/MS(26)
            PRINT 680,SSBD,DOF(22),MS(22),F(22)
            SSABD=ABD1-AB1-AD1-BD1+A1+B1+D1-X
680         FORMAT(1HO.10X,4HSSBD,9X,4F10.2)
            DOF(23)=(P-1.0)*(Q-1.0)*(U-1.0)
            MS(23)=SSABD/DOF(23)
            F(23)=MS(23)/MS(26)
            PRINT 690,SSABD,DOF(23),MS(23),F(23)
690         FORMAT(1H.0.10X,5HSSABD,8X,4F10.2)
            SSBCD=BCD1-BD1-BC1-CD1+B1+C1+D1-X
            DOF(24)=(Q-1.0)*(R-1.0)*(U-1.0)
            MS(24)=SSBCD/DOF(24)
            F(24)=MS(24)/MS(26)
            PRINT 700,SSBCD,DOF(24),MS(24)F(24)
700         EORMAT(1HO.10X,5HSSBCD,8X,4F10.2)
            SSABCD=ABCD1-ABC1-ABD1-ACD1-BCD1+AB1+AC1+AD1+BC1+BD1
           1+CD1-A1-B1-C1-D1+X
            DOF(25)=(P-1.0)*(Q-1.0)*(R-1.0)*(U-1.0)
            MS(25)=SSABCD/DOF(25)
            F(25)=MS(25)/MS(26)
            PRINT 710,SSABCD,DOF(25),MS(25),F(25)
710         FORMAT(1.HO.10X,6HSSABCD,7X,4F10.2)
            PRINT 715,SS26,DOF(26),MS(26)
715         FORMAT(1HO.10X,10HSSBDSUBWGR,3X,3F10.2)
            SS31=ABCES1-ABCE1-ABCS1-ACES1+ABC1+ACE1+ACS1-AC1
            DOF(31)=P*R*(Q-1.0)*(N-1.0)*(V-1.0)
```

```
20          1,=  .  .  \ ?,
            MS(31)=SS31/DOF(31)
            SSBE=BE1-B1-E1+X
            DOF(27)=(Q-1.0)*(V-1.0)
            MS(27)=SSBE/DOF(27)
            F(27)=MS(27)/MS(31)
            PRINT 720,SSBE,DOF(27),MS(27),F(27)
720         FORMAT(1HO.10X,4HSSBE,9X,4F10.2)
            SSABE=ABE1-AB1-AE1-BE1+A1+B1+E1-X
            DOF(28)=(P-1.0)*(Q-1.0)*(V-1.0)
            MS(28)=SSABE/DOF(28)
            F(28)=MS(28)/MS(31)
            PRINT 730,SSABE,DOF(28),MS(28),F(28)
730         FORMAT(1HO.10X,5HSSABE,8X,4F10.2)
            SSBCE=BCE1-BC1-BE1-CE1+B1+C1+E1-X
            DOF(29)=(Q-1.0)*(R-1.0)*(V-1.0)
            MS(29)=SSBCE/DOF(29)
            F(29)=MS(29)/MS(31)
            PRINT 740,SSBCE,DOF(29),MS(29),F(29)
740         FORMAT(1HO.10X,5HSSBCE,8X,4F10.2)
            SSABCE=ABCE1-ABC1-ABE1-ACE1-BCE1+AB1+AC1+AE1+BC1+BE1+CE1
           1-A1-B1-C1-E1+X
            DOF(30)=(P-1.0)*(Q-1.0)*(R-1.0)*(V-1.0)
            MS(30)=SSABCE/DOF(30)
            F(30)=MS(30/MS(31)
            PRINT 750,SSABCE,DOF(30),MS(30),F(30)
750         FORMAT(1HO.10X,6HSSABCE,7X,4F10.2)
            PRINT 755,SS31,DOF(31),MS(31)
755         FORMAT(1HO.10X,10HSSBESUBWGR,3X,3F10.2)
            SS36=ACDES1-ACDE1-ACDS1-ACES1+ACD1+ACE=+ACS1-AC1
            DOF(36)=P*R*(U-1.0)*(V-1.0)*(N-1.0)
            MS(36)=SS36/DOF(36)
            SSDE=DE1-D1-E1+X
            DOF(32)=(U-1.0)*(V-1.0)
            MS(32)=SSDE/DOF(32)
```

```
21          F(32)=MS(32)/MS(36)
            PRINT 760,SSDE,DOF(32),MS(32),F(32)
760         FORMAT(1HO.10X,4HSSDE,9X,4F10.2)
            SSADE=ADE1-AD1-AE1-DE1+A1+D1+E1-X
            DOF(33)=(P-1.0)*(U-1.0)*(V-1.0)
            MS(33)=SSADE/DOF(33)
            F(33)=MS(33)/MS(36)
            PRINT 770,SSADE,DOF(33),MS(33),F(33)
770         FORMAT(1HO.10X,5HSSADE,8X,4F10.2)
            SSCDE=CDE1-CD1-CE1-DE1+C1+D1+E1-X
            DOF(34)=(R-1.0)*(U-1.0)*(V-1.0)
            MS(34)=SSCDE/DOF(34)
            F(34)=MS(34)/MS(36)
            PRINT 780,SSCDE,DOF(34),MS(34),F(34)
780         FORMAT(1HO.10X,5HSSCDE,8X,4F10.2)
            SSACDE=ACDE1-ACD1-ACE1-CDE1+AC1+AD1+AE1+CD1+CE1+DE1-A1-C1-D1-E1+X
           1-ADE1
            DOF(35)=(P-1.0)*(R-1.0)*(U-1.0)*(V-1.0)
            MS(35)=SSACDE/DOF(35)
            F(35)=MS(35)/MS(36)
            PRINT 790,SSACDE,DOF(35),MS(35),F(35)
790         FORMAT(1HO.10X,6HSSACDE,7X,4F10.2)
            PRINT 795,SS36,DOF(36),MS(36)
795         FORMAT(1HO.10X,10HSSDESUBWGR,3X,3F10.2)
            SS41=A61-ABCDE1-ABCDS1-ABCES1-ACDES1+ABCD1+ABCE1+ACDE1+ABCS1+
           1ACDS1+ACES1-ABC1-ACD1-ACE1-ACS1+AC1
            DOF(41)=P*R*(N-1.0)*(Q-1.0)*(U-1.0)*(V-1.0)
            MS(41)=SS41/DOF(41)
            SSBDE=BDE1-BD1-BE1-DE1+B1+D1+E1-X
            DOF(37)=(Q-1.0)*(U-1.0)*(V-1.0)
            MS(37)=SSBDE/DOF(37)
            F(37)=MS(37)/MS(41)
            PRINT 800,SSBDE, DOF(37),MS(37),F(37)
800         FORMAT(1HO.10X,5HSSBDE,8X,4F10.2)

            SSABDE=ABDE1-ABD1-ABE1-ADE1-BDE1+AB1+AD1+AE1+BD1+BE1+DE1-A1-
           1B1-D1-E1+X
```

```
22          DOF(38)=(P-1.0)*(Q-1.0)*(U-1.0)*(V-1.0)
            MS(38)=SSABDE/DOF(38)
            F(38)=MS(38)/MS(41)
            PRINT 810,SSABDE,DOF(38),MS(38),F(38)
            DOF(39)=(Q-1.0)*(R-1.0)*(U-1.0)*(V-1.0)
810         FORMAT(1HO.10X,6HSSABDE,7X,4F10.2)
            SSBCDE=BCDE1-BCD1-BCE1-BDE1-CDE1+BC1+BD1+BE1+CD1+CE1+DE1-
           1B1-C1-D1-E1+X
            MS(39)=SSBCDE/DOF(39)
            F(39)=MS(39)/MS(41)
            PRINT 820,SSBCDE,DOF(39),MS(39),F(39)
820         FORMAT(1HO.10X,6HSSBCDE,7X,4F10.2)
            SS40=ABCDE1-ABCD1-ABCE1-ABDE1-ACDE1-BCDE1-AB1-AC1-AD1-AE1-
           1BC1-BD1-BE1-CD1-CE1-DE1+A1+B1+C1+D1+E1-X+ABC1+ABD1+ABE1+
           2ACD1+ADE1+BCD1+ BCE1+BDE1+CDE1+ACE1
            DOF(40)= (P-1.0)*(Q-1.0)*(R-1.0)*(U-1.0)*( V-1.0)
            MS(40)=SS40/DOF(40)
            F(40)=MS(40)/MS(41)
            PRINT 830,SS40,DOF(40),MS(40),F(40)
830         FORMAT(1HO.10X,7HSSABCDE,6X,4F10.2)
            PRINT 835,SS41,DOF(41),MS(41)
835         FORMAT(1HO.10X,11HSSBDESUBWGR,2X,3F10.2)
            SSTOTL=A61-X
            DOF(42)=N*P*Q*R*U*V-1.0
            PRINT 840,SSTOTL,DOF(42)
 840        FORMAT(1HO.10X,7HSSTOTAL,6X,2F10.2)
            SS43=SS5+SS11+SS16+SS21+SS26+SS31+SS36+SS41
            DOF(43)=P*Q*R*U*V*(N-1.0)
            PRINT 850,SS43,DOF(43)
850         FORMAT(1HO.6X,12HSSWITHINCELL,3X,2F10.2)
            STOP
            END
            SUBROUTINE INPUT(L1,L2,I,ABCDES)
            DIMENSION ABCDES(28,28)
            COMMON NFLAG
```

```
23          IA=(I-1)*7
            DO 1 J=L1,L2,3
            DO 1 IB=1,7
            IZ=IA+IB
            READ2,Z1,Z2,Z3,Z4
            ABCDES(IZ,J)=(Z1+Z2+Z3+Z4)/4.0
            IF(NFLAG.EQ.2)ABCDES(IZ,J)=(ABS(Z1)+ABS(Z2)+ABS(Z3)+ABS(Z4)/4.0
          1 IF(NFLAG.EQ.3)ABCDES(IZ,J)=SQRT(((Z1**2+Z2**2+Z3**+Z4**2)*4.0)
           1-((Z1+Z2+Z3+Z4)**2))/4.0
          2 FORMAT(4F5.1)
            RETURN
            END
            SUBROUTINE OUTPUT(MATRIX,N,M,GRSUM,GRSQSM)
             REAL MATRIX(N,M)
            DO 3  I=1,N
          3 PRINT 1, (MATRIX(I,J),J=1,M)
          1 FORMAT(1H,11F12.3)
            PRINT 2,GRSUM,GRSQSM
          2 FORMAT(1HO,5X,6HGRSUM=,F12.3,5X,7HGRSUSM=,F13.3)
            RETURN
            END
            SUBROUTINE MERG2(D,S,DX,DY,SX,SY,MRG,GRSUM,GRSQSM)
C           THIS SUB MERGES ROWS 1,MRG/MRE+1
            INTEGER  DX,DY,SX,SY,MRG,DZ
            DIMENTION D(DX,DY),S(SX,SY)
            CALL INIT(GRSUM,GRSQSM)
            DZ=DY-2
            DO 1 I=1,DX
            LA=(I-1)*MRG
            DO 2 J=1,DZ
            DO 3 IB=1,MRG
            IZ=IA+IB
          3 D(I,J)=D(I,J)+S(IZ,J)
            D(I,DY-1)=D(I,DY-1)+D(I.J)
          2 D(I,DY)=D(I,DY)+D(I,J)**2
```

```
24          GRSUM=GRSUM+D(I,DY-1)
          1 GRSQSM=GRSQSM+D(I,DY)
            RETURN
            END
            SUBROUTINE COLM1(D,S,DX,DY,SX,SY,MRG,GRSUM,GRSQSM)
C           MERGES COLMS 1,MRG/MRG+1
            INTEGER DX,DY,SX,SY,DZ
            DIMENSION D(DX,DY),S(SX,SY)
            DZ=DY-2
            CALL INIT(GRSUM,GRSQSM)
            DO 1 I=1,DX
             DO 2 J=1,DZ
            JA=(J-1)*MRG
            DO 3 JB=1, MRG
            JZ=JA+JB
          3 D(I,J)=D(I,J)+S(I,JZ)
            D(I,DY-1)=D(I,DY-1)+D(I,J)
          2 D(I,DY)=D(I,DY)+D(I,J)**2
            GRSUM=GRSUM+D(I,DY-1)
          1 GRSQSM=GRSQSM+D(I,DY)
            RETURN
            END
            SUBROUTINE COLM2(D,S,DX,DY,SX,SY,FAR,GRSUM,GRSQSM)
C           MERGES COLMS I,I+FAR,I+FAR+2
            INTEGER DX,DY,SX,SY,FAR,DZ
            DIMENSION D(DX,DY),S(SX,SY)
             DZ=DY-2
            CALL INIT(GRSUM,GRSQSM)
            DO 1 I=1,DX
            DO 2 J=1,DZ
            J1=J+FAR
            J2=J1+FAR
            D(I,J)=S(I,J)+S(I,J1)+S(I,J2)
            D(I,DY-1)=D(I,DY-1)+D(I,J)
```

```
      D(I,JC-1)=D(I,JC-1)+D(I,1)
      D(I,1)=B(I,1)+B(I,11)+B(I,15)
      JS=JJ+NM
      JJ=1+NM
      DO 5 I=1,DS
      DO 1 I=1,DX
      CALL TIME1(DSECN,MSECN)
       DS=DX-5
      DIMENSION D(DX,DA),S(XS,XS)
      IMPLICIT DX,DA,XS,XS,XS,DS
C     MEMBER COUNT I,I+NM,I+2*NM
      SUBROUTINE COMPS(D,S,DX,DA,XS,XS,XS,DSECN,MSECN,NMSEC)
      END
      MEMBER
    4 C=SECN-MSECN+D(I,DX)
      MSECN=MSECN+D(I,DX-1)
    5 D(I,DA)=D(I,DX)+D(I,1)*NM
      D(I,DA-1)=D(I,DA-1)+D(I,1)
    3 D(I,1)=D(I,1)+B(I,XS)
      JS=JA+XS
      DO 3 JE=1,NMC
      JA=(J-1)*NMC
       DO 5 I=1,DS
      DO 1 I=1,DX
      CALL TIME1(DSECN,MSECN)
      DS=DX-5
      DIMENSION D(DX,DA),S(XS,XS)
      IMPLICIT DX,DA,XS,XS,XS,DS
C     MEMBER COUNT I,I+NM,I+2*NM
      SUBROUTINE COMPS(D,S,DX,DA,XS,XS,XS,DSECN,MSECN,NMSEC)
      END
      MEMBER
    4 C=SECN-MSECN+D(I,DX)
      MSECN=MSECN+D(I,DX-1)
```

```
25          2 D(I,DY)=D(I,DY)+D(I,J)**2
              GRSUM=GRSUM+D(I,DY-1)
            1 GRSQSM=GRSQSM+D(I,DY)
              RETURN
              END
              SUBROUTINE ARRANGE(D,S,DX,DY,SX,SY,X,Y)
C             ADDS ROWS 1+2 AND ARRANGES IN D BY ROW
              INTEGER DX,DY,SX,SY,DZ
              DIMENSION D(DX,DY),S(SX,SY)
              CALL INIT(X,Y)
               DZ=DY-2
              DO 1 I=1,DX
              DO 2 J=1,DZ
              JA=(I-1)*(DY-2)+J
              D(I,J)=S(1,JA)+S(2,JA)
              D(I,DY-1)=D(I,DY-1)+D(I,J)
            2 D(I,DY)=D(I,DY)+D(I,J)**2
              X=X+D(I,DY-1)
            1 Y=Y+D(I,DY)
              RETURN
              END
              SUBROUTINE INIT(X,Y)
              X=0.0
              RETURN
              END
```

LIST OF INSTITUTIONS WHERE DATA WERE COLLECTED

Sri Hanuman Prasad Poddar Andh Vidyalaya,
Durgakund,
Varanasi (U.P.).

Workshop for the Blind,
Dr. Annie Besant Road,
Worli,
Bombay 400 025.

Dadar School for the Blind,
160, Dadasaheb Phalke Road,
Dadar,
Bombay 400 014.

The Victoria Memorial High School for the Blind,
Tardeo
Bombay 400 034.

The N.S.D. Industrial Home for the Blind,
B.D.D. Block 52,
Worli,
Bombay 400 018.

The M.N. Banajee Industrial Home for the Blind,
'Chateau Dieu',
280, S.V. Road,
Jogeshwari,
Bombay 400 060.

Haji A. Sonawala Andh and Anath Stree Ashram,
37, Gilbert Hill, Dadabhai Road,
Andheri,
Bombay 400 058.

The Blind Men's Industrial Co-Operative Producers
Society Ltd.,
22/686, M.H.B., Tagore Nagar,
Vikhroli,
Bombay 400 083.

The Poona School and Home for the Blind,
14-17 Koregaon Park,
Pune - 1.

Industrial Workshop and Home for the Blind,
Hadpsar,
Pune.

Blind Boys' Institute and Sheltered Workshop for the Blind,
Blind Relief Association,
South Ambazari Road,
Nagpur - 10.

School for the Blind,
Blind Welfare Association,
Amaravati.

Govt. School for the Blind,
Basanthi Havdi,
Salarjung Estate,
Hyderabad 500 002.

Hostel for the Blind,
Yakutpura,
Hyderabad 500 023.

Hostel for the Blind,
Dewan Dewadi,
Hyderabad.

Training Centre for Adult Deaf,
Govt. of India,
Malkpet,
Hyderabad 500 036.

Harish Chandra Intermediate College,
Varanasi (U.P.).

Gujarat Vidya Mandir High School
Varanasi (U.P.).

Department of Military Science,
University of Gorakhpur,
Gorakhpur (U.P.).

Central Training Institute,
Vidyanagar,
Hyderabad - 7.

Indian Institute of Technology,
Bombay 400 076.

LIST OF PAPERS PUBLISHED/ COMMUNICATED/PRESENTED

1. Kool, V.K. Short-Term Recall of Linear and Curvilinear Movements in Blind and Sighted Subjects. Chapter 27 in R.S. Nickerson (Ed.), Attention and Performance, Vol.8, Princeton, New Jersy (U.S.A.): Lawrence Erlbaum Associates, 1980.

2. Kool, V.K., and Rana, M. Tactual Short Term Memory of Blind and Sighted Children. Psychologia, Japan, 1979, 23, 173-178.

3. Kool, V.K., and Rana, M. Tactual Short Term Memory of Blind and Sighted Adults. Paper presented in the Centenary Celebration: 100 Years of Experimental Psychology, Calcutta University, Calcutta, December 24-25, 1979.

4. Kool, V.K., and Singh, S.J. A Study of Preselection and Response Biasing in Short Term Recall of Movements. Paper presented in The U.G.C. Symposium in Psychology, Karnataka University, Dharwad, March 8-11, 1980.

5. Kool, V.K., and Singh, S.J. Role of Visual Reference System and Motor Interference in Coding of Isolated Movement Cues: Some Implications Based on Proactive Inhibition Paradigm. Paper presented in The Symposium on Experimental Methodology, Design and Instrumentation, University of Poona, Poona, June 9-11,1980.

6. Kool, V.K., Singh, S.J. and Pathak, K.C. Response Biasing in Blind and Sighted Subjects. Paper presented in The Centenary Celebration: 100 Years of Experimental Psychology, Calcutta University, Calcutta, December 24-25, 1979.

7. Kool, V.K., Singh, S.J., and Pathak, K.C. Directional Shift in Memory Trace as Related to Prior Visual Experience. Bombay Psychologist, in Press.

8. Kool, V.K. Some methodological issues in the study of motor short term memory. UGC Symposium of Psychology: Psychology Department, Karnataka University, Dharwad, June, 1979.

9. Kool, V.K. Motor memory of blind and sighted people. Invited lecture at ETS, Princeton, N.J. U.S.A. in Attention and Performance Symposium, August, 1978.

10. Kool, V.K. Memory of blind people: Lectures at University of Wisconsin, Madison, Sept. 1978; National Institute for Visually handicapped, Dehra Dun, Feb. 1980; and Workshop for the blind, Worli, Bombay, May, 1981.

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